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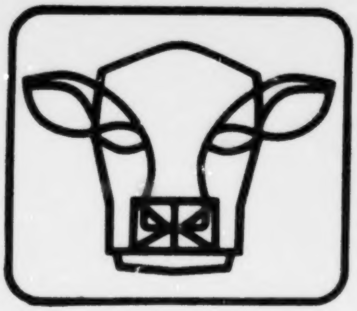

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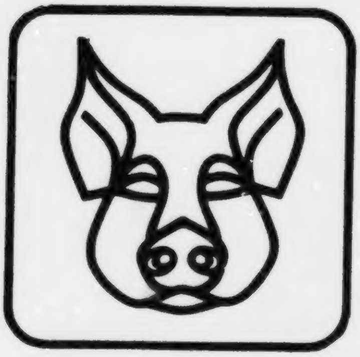

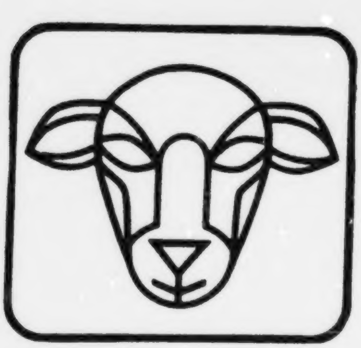

A Forum for Professionals in Animal Agriculture

Manitoba
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ATROBAN AND ECTIBAN INSECTICIDE EAR TAGS - PRINCIPLES AND ECONOMICS OF INSECT CONTROL ON CATTLE

Peter R. Crowe-Swords

Coopers Agropharm Inc.

INTRODUCTION

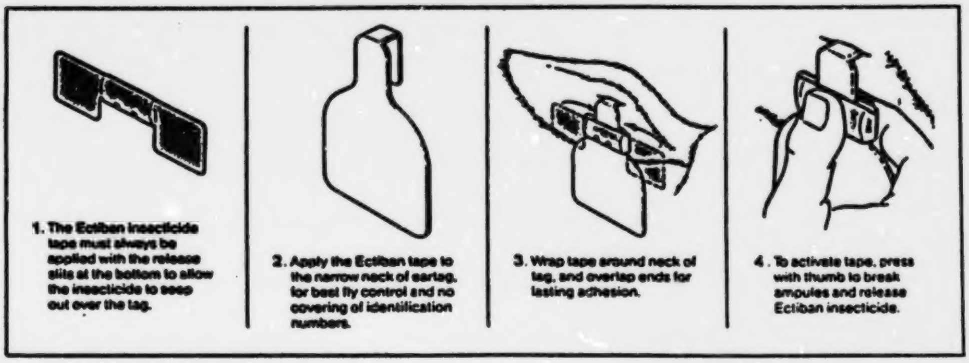
Coopers has two permethrin insecticides which are commercially available to the Canadian livestock industry. Atroban ear tags were approved for horn fly control of beef and dairy cattle in the spring of 1983. Atroban ear tags have been shown to provide greater than 99% season long control of horn flies, when applied at the rate of one per animal. We are awaiting product registration for control of face flies and tag application to calves of less than six months of age.

Ectiban emulsifiable liquid concentrate is registered for the control of a wide range of biting and nuisance flies, which include, horn flies face flies and house flies. It is the only permethrin product approved for the control of black flies. The second Ectiban product being developed is a tag-tape for control of biting flies on cattle. The Ectiban tag-tape is applied to the permanent identification tag (Figure 1), thus eliminating the need for double tagging with both identification and insecticide tags. We foresee the greatest use of the tag-tape will be in the purebred beef dairy herds, where additional tags create problems. The registration of Ectiban insecticide tag-tapes is expected before the 1986 fly season.

FIGURE 1

THE APPLICATION PROCEDURE FOR APPLYING

ECTIBAN INSECTICIDE EAR TAG TAPES



1. The Ectiban insecticide tape must always be applied with the release slits at the bottom to allow the insecticide to seep out over the tag.
2. Apply the Ectiban tape to the narrow neck of eartag, for best fly control and no covering of identification numbers.
3. Wrap tape around neck of tag, and overlap ends for lasting adhesion.
4. To activate tape, press with thumb to break ampoules and release Ectiban insecticide.

TAGGED COWS V TAGGED CALVES

There has been much debate over whether insecticide ear tags should be applied to the cow or calf. As has been mentioned previously, one Atroban insecticide ear tag will give better than 99% season long control of horn flies. This is achieved by the permethrin being released slowly from the tag. Approximately 50% of the permethrin would be released from the tag in the first 35 to 40 days after application. By the completion of approximately 120 days the minimum effect delivery rate of 1.5 mg per day is still obtained, thus, season long protection against horn flies is achieved. If the insecticide tags are placed on the calves of cow/calf pairs, the minimum effective delivery rate of 1.5 mg of permethrin per day may not always be achieved on the cow, since the transfer of the permethrin from the calf may not be 100%. Data collected from three herds in 1985, each with an untagged control group, an Atroban tagged cow group and an Atroban tagged calf group demonstrate the effects on the horn fly control (Table 1). The mean number of horn flies and percent control for the three treatments in each herd have been pooled together. Four weeks after the tags were applied, one Atroban tag per cow gave 92% control and one Atroban tag per calf gave 62% control of horn flies on the cows. Ten weeks after the tags were applied, (at the peak of the fly season), one Atroban tag per cow gave 99% control and one Atroban tag per calf gave 96% control.

TABLE 1

MEAN NUMBER OF HORN FLIES PER COW AND PERCENT CONTROL FOR COWS TAGGED AND CALVES TAGGED WITH ATROBAN EAR TAGS

		CONTROL	ATROBAN ON COWS		ATROBAN ON CALVES	
DATE	WEEKS TAGGED	NO.HORN FLIES	NO.HORN FLIES	% CONTROL	NO.HORN FLIES	% CONTROL
June 5	1	9	9	-	9	-
June 28	4	26	2	(92%)	10	(62%)
August 8	10	225	2	(99%)	10	(96%)

These data would suggest that the application of insecticide ear tags to the adults of the cow/calf pairs gives the quickest and highest control of horn flies.

ECONOMIC LOSS IN PRODUCTION

When horn fly populations reach 50 to 100 flies per adult animal it is possible to obtain substantial reductions in weight gain. If cows nursing calves are exposed to similar horn fly numbers, a reduction in the rate of gain of the calf can also be expected. Dr. Haufe, at the Agriculture Research Station, Lethbridge, Alberta has demonstrated that when horn fly populations are as low as 10 flies per aniaml a reduction of 16% in the rate of gain can be expected for any given set of pastures conditions. This loss is a result of the changes or reduction in the time spent grazing and a reduced utilization of available forage.

A study was started by Coopers in 1985 to evaluate the economics of horn fly control on the growth rate of calves and yearlings using Atroban ear tags and Ectiban ear tag tapes. A total of 6 herds and 1,230 cow/calf pairs or yearlings were involved in the study. In each herd, separate pastures were used for different treatments. In addition there was an untagged control group and from one to three treatment groups in each herd. The treatment groups were Atroban tagged calves, Atroban tagged cows and Ectiban tag-taped cows. Unfortunately, the 1985 drought conditions in Western Canada forced a number of the cooperating herds to combine or sell individual groups of cattle. Nevertheless an analysis of the calf rate of gain data (Table 2) demonstrates that additional gains varied between 7.1 pounds and 55.6 pounds for an average of 18 pounds.

TABLE 2

THE EFFECT OF ATROBAN EAR TAGS AND ECTIBAN EAR TAG TAPES ON AVERAGE DAILY GAIN (lbs.) AND TOTAL GAIN (lbs.) OF CALVES FOR A 118 DAY GRAZING PERIOD

	CONTROL	ECTIBAN ON COWS	ATROBAN ON COWS	ATROBAN ON CALVES
No. of cow/calf pairs	33	31	98	101
Average daily gain	2.31	2.78	2.37	2.4
Total gain 118 days	272.6	328.2	279.7	290.0
Additional gain	-	55.6	7.1	17.4

Although the results are positive, no additional conclusions can be drawn from this study, since the data base maybe too small and enviromental variables may be too great.

CONCLUSION

When the beef producer considers using insecticide ear tags for the control of horn flies, consideration needs to be given to which animals to tag. One insecticide tag per adult animal will give better than 99% season long control of horn flies. If calves are tagged 96% control will be achieved on the dam.

Insecticide ear tags can give considerable improvements in the rate of gain of yearlings and calves. A minimum of 18 pounds can be expected under good grazing conditions.

SALINOMYCIN - A NEW IONOPHORE FOR CANADIAN AGRICULTURE

W.R. Cox, D.V.M., Pfizer Canada Inc.

COXISTAC is a new ionophorous anticoccidial feed additive for the Canadian poultry market. The active ingredient, salinomycin, is not only an effective coccidiocidal antibiotic, but has also been found to have useful properties as a growth promotant for pigs and cattle. In this paper, I will discuss briefly the drug itself and some of the experimental findings which demonstrate its use in chickens, pigs, and cattle.

Salinomycin and its mode of Action

Salinomycin is an ionophorous antibiotic which is produced by a strain of Streptomyces albus. It's structural formula (Fig.1), is similar to that of other ionophores. Salinomycin is supplied as a premix containing 60 grams of salinomycin sodium per Kilogram.

The class name, ionophore, when literally translated means "ion-bearer". This name describes, at a molecular level, the way in which these drugs work. By complexing with cations, the ionophore facilitates the transfer of those ions across cell membranes. Salinomycin preferentially complexes with monovalent alkali metals, the most important of which is Na^+.

Sodium ions, along with other mono-and divalent cations and anions, must be maintained at a precise balance within the parasite cell in order to preserve the life of the cell. Sodium within the normal cell is present at a lower concentration than that found outside, thus there is a concentration gradient for sodium into the cell. This gradient is counter balanced by the so-called "sodium pump" which actively removes Na^+ from the cell. The sodium pump is an energy utilizing biochemical system.

When an ionophore is introduced, excess sodium is carried into the cell, thereby requiring extra work of the sodium pump. It appears, then, that the excess intracellular sodium overwhelms the pump and, as the cell depletes itself of energy, Na^+ concentrations become increasingly higher. By normal osmotic processes, water will follow the sodium into the cell, causing pathological swelling and, eventually, lysis. This mechanism explains the coccidio-and bacteriocidal nature of the ionophore anitibiotics.

Salinomycin for Chickens

The first use for which salinomycin has been cleared in Canada is as an anticoccidial feed additive to be fed to broiler chickens at 60ppm of complete feed. Salinomycin is a potent broad spectrum anticoccidial with excellent efficacy against the six major species of Eimeria encountered in chickens. Table 1 shows the anticoccidial efficacy, as measured by lesion scores, of two ionophores against these important poultry coccidia. This demonstrates the broad spectrum activity of salinomycin.

Coccidiosis in chickens is, in its clinical form, a devasting disease to the host. The life cycle of the parasite (see figure 2) takes approximately seven days, during which time the organism goes through two stages of asexual multiplication, called schizogony, and a sexual stage called gametogony. A single sporozoite (the infective cell emerging from the oocyst) infecting a chicken produces, through schizogony, thousands of offspring or merozoites, each of which infects and destroys a cell within the intestine. It is during the second stage of schizogony and gametogony that the greatest amount of damage is caused by this parasite.

Salinomycin has its greatest effect early in the life cycle, on sporozoites and first generation merozoites. Some effect is also seen on immature schizonts, the intracellular cyst in which that organism is multiplying. This is of immense benefit in that it kills these parasites before they get to the point at which the greatest intestinal damage occurs.

When a producer uses a modern coccidiostat in his feed, he expects that product to control coccidiosis. Our work clearly demonstrates the efficacy of salinomycin against the various species of Eimeria. The next questions to be asked, then, is "how will the birds perform when they are on salinomycin?"

Numerous efficacy trials have been conducted, including floor pen studies in the presence and absence of coccidial infection, and commercial studies with various anticoccidials currently on the market as positive controls. These studies have been carried out in Canada as well as internationally. Table 2, 3 and 4 summarize the efficacy of salinomycin when fed to infected birds in floor pen studies. As expected, there is a marked improvement in performance as a result of the control of coccidiosis.

Floor pen studies conducted in coccidiosis-free conditions indicate no significant overall growth depression. This is illustrated in Table 5, a summary of 3 Canadian studies. When this was examined in sexed birds, a slight growth depression was seen in male broilers, as indicated in Tables 6 and 7. This effect appears to be common among the ionophores. Because of this finding, a statement to this effect is found on the Coxistac label.

A large number of commercial studies have been run worldwide. The results of these studies are expressed in Table 8 and 9. Table 8 shows the efficacy of salinomycin against various positive controls in trials in Canada. A summary of international commercial trials is expressed in Tabel 9. These data indicate the efficacy of salinomycin in the commercial situation.

Salinomycin for Swine

Salinomycin has been extensively studied in various species of animals. During the course of these studies, it was found that this product was an effective growth promotant in pigs. It should be pointed out that, at this writing, salinomycin is not cleared for use in swine, although it is being used in other parts of the world.

A number of trials have been conducted in Canada. Table 10 summarizes the results of these trials in which Salinomycin was fed at 25ppm of the complete feed. These data are taken through grower and finisher phases with final weights taken at market weight. As evidenced by this information, salinomycin can be seen to produce an average improvement of 5.9% in average daily gain, 4.5% improvement in feed efficiency, resulting in pigs going to market slightly better than 5 days earlier than non-medicated controls.

When this information is examined by production phase, the improved performance can be seen to be consistent through both grower and finisher periods. This is summarized in Table 11.

Salinomycin for Beef Cattle

As with salinomycin use in pigs, the indication of this product for beef cattle is not yet cleared in Canada. It is being used in some countries for this use and has been widely researched in this species.

It is actually a misnomer to refer to ionophores as growth promotants in beef cattle. When salinomycin (or any other ionophore) is fed to ruminant at appropriate levels, the effect is to alter the pattern of volatile fatty acid production, resulting in increased propionic acid, at the expense of acetic acid and butyric acid (Fig. 3). Propionic acid is the most efficient source of energy derived from rumen fermentation. Thus by increasing the amount of this volatile fatty acid, more total energy can be derived from the ration. It is in this manner that salinomycin becomes an agent of improved feed efficiency. While increased growth may be seen, it is through improved feed efficiency that ionophores have the greatest benefit.

Three trials have been conducted in Canada to evaluate the efficacy of salinomycin when fed to feedlot beef cattle at 100mg per head per day. Table 12 summarizes the results of these studies. Averaged over the three trials, salinomycin treatment resulted in a 7% improvement in feed efficiency and a 4.6% improvement in growth.

Salinomycin is proving to be a widely useful tool for the agricultural community. While Coxistac for control of coccidiosis in poultry is currently its only approved use in Canada, I look for other approvals to be forthcoming in the not too distant future.

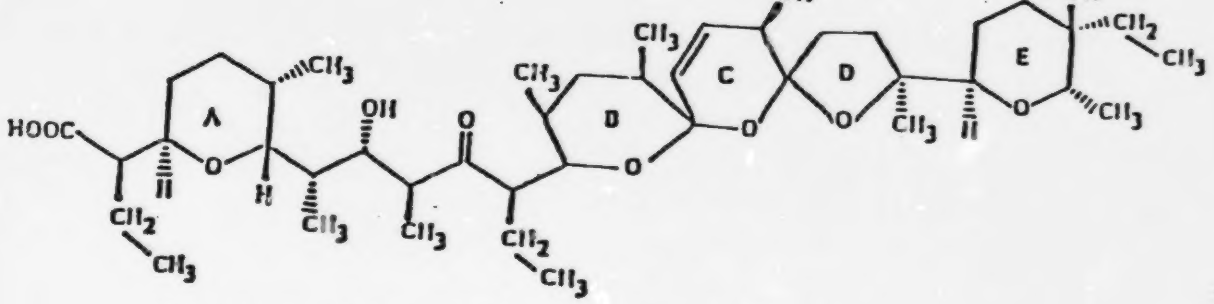

HOOC
A
B
C
D
E
OH
O

FIGURE 1 - Structural formula of Salinomycin

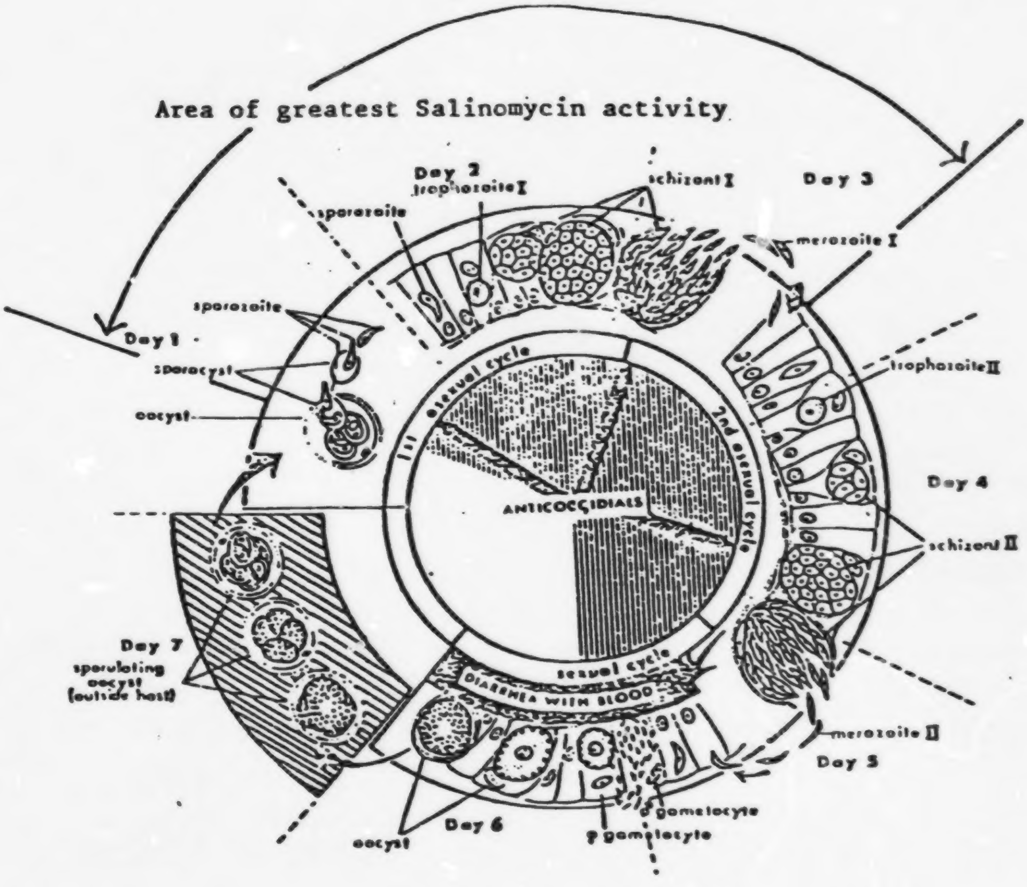

Area of greatest Salinomycin activity
Day 1
sporozoite
sporocyst
oocyst
Day 2
trophozoite I
sporozoite
schizont I
Day 3
merozoite I
trophozoite II
Day 4
schizont II
merozoite II
Day 5
♂ gametocyte
♀ gametocyte
Day 6
oocyst
Day 7
sporulating oocyst (outside host)
1st asexual cycle
2nd asexual cycle
sexual cycle
DIARRHEA WITH BLOOD
ANTICOCCIDIALS

FIGURE 2 - Life cycle of Eimeria tenella, showing area of greatest Salinomycin activity.

TABLE 1 - Mean coccidiosis lesion scores in chicken fed Monensin or Salinomycin as compared to unmedicated controls.

Species	No.of Trials	Inf/Untreated	Monensin	Salinomycin
E.acervulina	5	1.63	.24	0
E.brunetti	5	1.64	.54	.56
E.maxima	5	1.74	.38	.37
E.mivati	3	1.42	.03	0
E.necatrix	4	1.46	.09	0
E.tenella	5	2.77	.37	.22

TABLE 2 - Lesion scores of birds infected with mixed species of coccidia and fed either salinomycin treated or non-medicated rations.

Treatment	Upper S.I.	Middle S.I.	Lower S.I.	Cecum	Total	% Reduction
Infected Control	1.25	3.2	0	2.35	6.80	-
Salinomycin	0	0	0	0	0	100%

TABLE 3 - Mortality of birds infected with mixed species of coccidia and fed either Salinomycin-treated or non-medicated rations.

Treatment	Total Mortality	Mortality due to Coccidiosis
Infected Control	16.8%	14.1%
Salinomycin	3.6%	0.0%

TABLE 4 - Performance of birds infected with mixed species of coccidia and fed either Salinomycin-treated or non-medicated rations.

Treatment	Av.Wt.Gain	Index	Feed/Gain	Index
Infected Control	1786.4g[a]	100.0	2.530[a]	100.0
Salinomycin	1891.7g[b]	105.9	2.265[b]	111.7

TABLE 5 - Unweighted average of three floor pen studies conducted in coccidiosis-free conditions.

	Average Weight		Feed Conversion	
	Grams	Index	Feed/Gain	Index
Non-Medicated	2158.5	100.0	2.15	100.0
Salinomycin	2141.2	99.2	2.09	102.9

TABLE 6 - Performance of female broilers in coccidiosis free conditions.

Treatment	Average Gain(g)	Index	Feed Conversion	Index
Non-Medicated	2022.04	100.0	1.9930[bc]	100.0
Salinomycin 60ppm	2023.78	100.1	1.9393[a]	102.8
Monensin 99ppm	2057.77	101.8	2.0246[c]	98.4
Lasolocid 100ppm	2055.37	101.6	1.9574[ab]	101.8

TABLE 7 - Performance of male broilers in coccidiosis free conditions.

Treatment	Average Gain(g)	Index	Feed Conversion	Index
Non-Medicated	2523.65[a]	100.0	1.8812[b]	100.0
Salinomycin 60ppm	2460.72[b]	97.5	1.8557[ab]	101.4
Monensin 99ppm	2402.29[b]	95.2	1.8605[ab]	101.1
Lasolocid 100ppm	2415.62[b]	95.7	1.8183[a]	103.4

TABLE 8 - Summary of Canadian commercial studies comparing Salinomycin treated birds against other anticoccidial programs.

	No. of birds	40 day weight	Index	Feed Conversion	Index
Salinomycin	193079	2.061	100.3	2.052	101.1
Competitive Programs	252068	2.054	100.0	2.074	100.0

TABLE 9 - Summary of international commercial studies comparing Salinoymcyin treated birds against other anticoccidial programs.

Trials	Treatment	Initial No. Birds	Days on Test	% Mortality	Final Weight Kg.	Final Weight Index	Feed Efficiency F/G	Feed Efficiency Index
26	Salinomycin 60ppm	208,644	58.5	3.5	1.841	103.3	2.387	102.3
26	All competitive products	214,086	58.5	3.6	1.782	100.0	2.441	100.0

TABLE 10 - Summary of 6 Canadian trials, feeding Salinomycin to pigs through the grower and finisher periods.

	Average Daily Gain (KG)	Feed/Gain	Average Days to Market
Unmedicated Control	0.680^c	3.409^c	108.87^c
Salinomycin 25ppm	0.720^d	3.261^d	103.52^d

c,d - Values in columns with different superscripts are significantly different ($p < 0.01$).

TAPLE 11 - Summary of 4 trials evaluating performance by growing period of pigs fed Salinomycin.

	Unmedicated Control	Salinomycin 25ppm	Index
Grower Period			
ADG (KG)	0.578^e	0.604^f	104.5
Feed/Gain	3.121^c	3.010^d	103.7
Finisher Period			
ADG (KG)	0.678	0.709	104.6
Feed/Gain	3.959	3.844	103.0

c,d - difference significant to $p < 0.05$

e,f - difference significant to $p < 0.01$

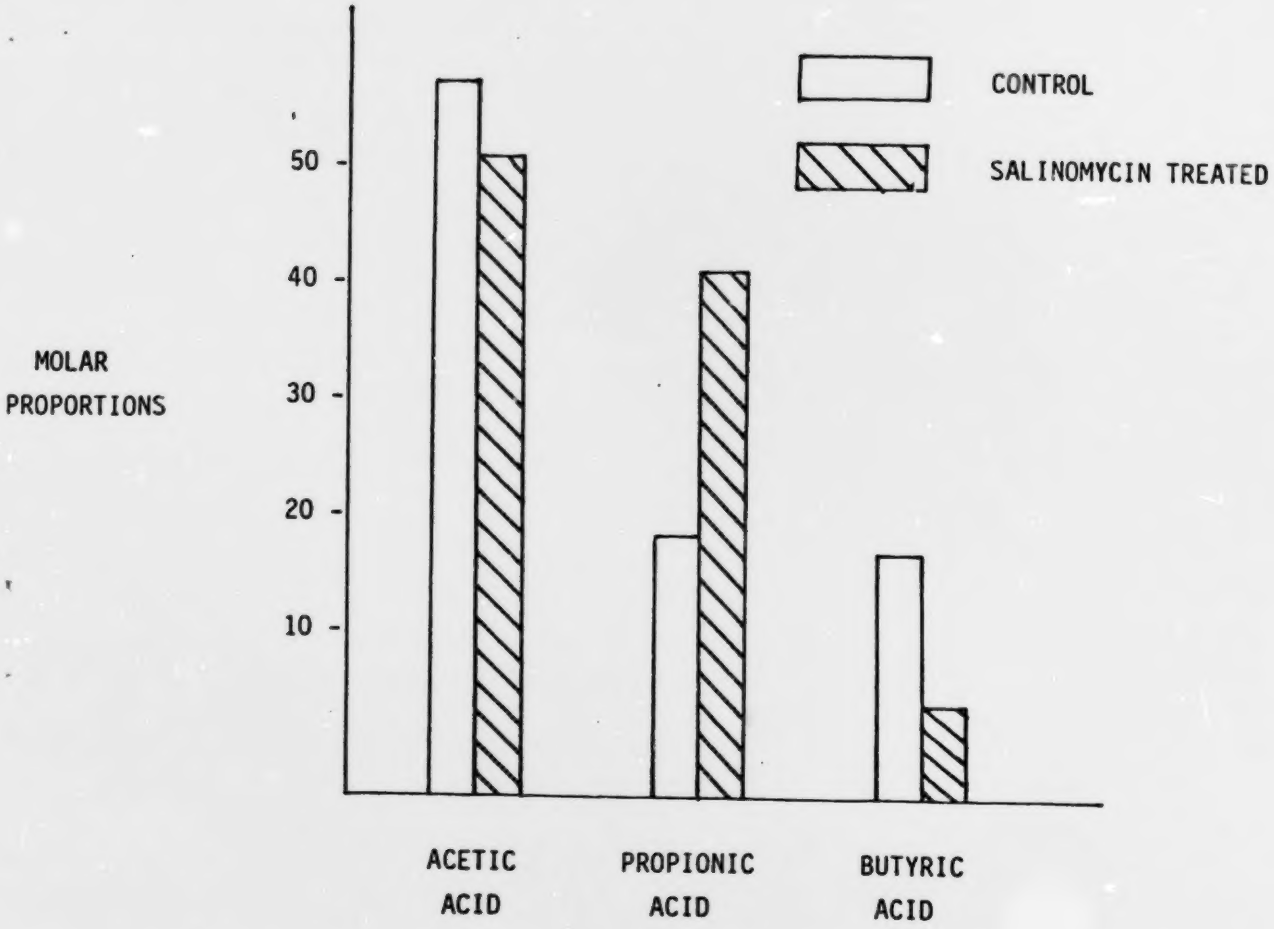


FIGURE 3 - Graphic representation of the molar proportions of the major ruminal volatile fatty acids with and without Salinomycin treatment.

TABLE 12 - Summary of 3 Canadian studies to evaluate the effect of Salinomycin treatment on feedlot beef cattle.

	No. Animals	A.D.G.(KG)	Index	F/G	Index
Control	110	1.08	100.0	7.43	100.0
Salinomycin	110	1.13	104.6	6.93	107.2

TYLAN 50 SULFA-G®*

FOR THE PREVENTION OF SWINE PNEUMONIA

John K. Merrill
Animal Science Field Research
Elanco, Division Eli Lilly Canada Inc.
Calgary, Alberta

In mammals, the lung is the organ used to exchange oxygen which is essential for life; and to eliminate some waste products such as carbon dioxide. The lung has a large reserve capacity but this reserve is seriously challenged and eventually over powered when the lung is compromised. Lung compromise usually comes in the form of inflammations. Inflammation of the lung is called pneumonitis, or more commonly, pneumonia.

The common pneumonias in swine are caused by several etiological agents. The etiological agents can be placed in four distinct categories: mycoplasmal, bacterial, viral and parasitic. It is not unusual to have more than one agent from a category, or even agents from two or more categories combining together to cause pneumonia; and almost invariably, more severe pneumonia than if only one agent from one category had been involved.

Environment also plays an important role in the etiology of swine pneumonia. Factors such as management practices, the production system, the barns, pens, heating, humidity, temperatures, season, weather changes, and numbers of animals/m^2, can be involved in the incidence and severity of swine pneumonia.

In comparing bacterial pneumonia and mycoplasmal pneumonia, bacterial pneumonia is the most severe, while the mildest pneumonia is mycoplasmal pneumonia. The most prevalent pneumonia in swine is one that is caused by Mycoplasma hyopneumoniae, the cause of chronic mycoplasmal pneumonia (formerly called virus pig pneumonia, VPP, or swine enzootic pneumonia, SEP). This pneumonia is a chronic, mild pneumonia usually involving relatively small areas of the apical and cardiac lobes and intermediate lobes of the lung. Under field conditions, however, animals with chronic mycoplasmal pneumonia almost always undergo secondary bacterial infections with agents such as Pasteurella multocida, Corynebacterium pyogenes, Bordetella bronchiseptica, or other bacteria. The mycoplasmal infection serves as a predisposing factor for bacterial infections which often occur at times of stress. Bacterial pneumonia may, however, occur without the mycoplasmal pneumonia. Bacterial involvement results in a more severe pneumonia, often resulting in a reduced growth rate and a measurable incidence of mortality.

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* Marketed by Elanco, Division of Eli Lilly Canada Inc., London, Ontario

Tylan Sulfa-G is the only feed additive registered in Canada for the prevention of swine pneumonia caused by Pasteurella multocida and Corynebacterium pyogenes.

Studies evaluating Tylan Sulfa-G for swine pneumonia prevention have been conducted under both laboratory (induced) conditions and field (natural) conditions.

Ose et. al. (1973) reported on a series of four trials evaluating Tylan Sulfa in preventing laboratory-induced pneumonia. The system by which pneumonia was induced consisted of two phases: (1) the initial step involved the oral administration of a known number of Ascaris suum (large roundworm) ova to each pig. (2) five to 10 days later, when migration of A. suum larvae was creating damage to the lung tissue, 5 to 10 mls. of a suspension of pneumonic swine lung containing viable Pasteurella multocida and Corynebacterium pyogenes was instilled intranasally into each animal.

A summary of the results of four trials is shown in table 1. Tylan Sulfa-G dramatically reduced mortality from 26.8% to 5.6% (79.1% reduction). Pneumonic lung lesions were reduced 49.3%. The pigs receiving Tylan Sulfa gained nearly 3.5 times as much as those on the control ration.

In another induced-pneumonia trial (Ose, unpublished data) the use of Tylan, sulfamethazine, and Tylan Sulfa-G were compared in a factorial arrangement of feed additive treatments. The pigs were on experimental rations for seven days prior to the A. suum ova challenge and the trials continued until 18 days after the lung suspension challenge. The data (table 2) show that the combination of Tylan and sulfamethazine was more effective than either drug alone in reducing mortality. The weight gain data also indicate that Tylan by itself did improve weight gains while sulfamethazine by itself did not.

The enhancement of Tylan with sulfamethazine is demonstrated in figure 1. This study is an in vitro study measuring the inhibition of Pasteurella multocida by tylosin and sulfamethazine. Sulfamethazine alone, even at 100 ppm concentration, did not show any inhibition of bacterial growth. Tylan alone showed some inhibition at all levels, with 100% inhibition at a concentration of 100 ppm. The synergism of Tylan and sulfamethazine is demonstrated by the significant increase in inhibition by the addition of even low levels of sulfamethazine to Tylan.

Sampson et. al. (1973) reported four trials demonstrating the efficacy of Tylan Sulfa-G on naturally-occurring swine pneumonia caused by bacterial pathogens, Pasteurella multocida and Corynebacterium pyogenes. The four trials involved 277 pigs of various breeds and of both sexes ranging in weight from 6.3 to 30.8 kgs. There was a high incidence of bacterial pneumonia (50 to 90%) in each of the herds that was a source for these pigs. The experiments were conducted for 19 to 22 days following the start of medicated feed. The data from each of the four trials as well as the pooled data are shown in table 3.

Tylan Sulfa-G was effective ($p < .05$) in reducing deaths from 16 out of 111 pigs in the untreated group to six out of 111 in the treated group.

All of the deaths were attributed to pneumonia. As a result of pneumonia prevention, pigs fed Tylan Sulfa-G gained 1.23 kg. more during the trials and required 0.28 kg. less feed per kg. of gain. Both these differences were significant (p<.05).

Two laboratory-induced pneumonia trials were conducted using Canadian bacterial isolates and two field condition studies were conducted in Canada to evaluate the use of Tylan Sulfa-G in the feed of pigs for the prevention of bacterial swine pneumonia.

In trial 1, 64 healthy pigs were purchased and divided into eight rooms of eight pigs per room. Four groups were fed a ration containing Tylan Sulfa-G (110 grams/tonne each) while the remaining four groups received the same ration without antimicrobial agents.

Pneumonia was induced similarly to the procedure of Ose et. al (1973), previously discussed. Pigs were observed individually on every third day of the trial and the presence of coughing and nasal exudate recorded. Body temperatures were recorded daily. Dead pigs were subjected to post-mortem examination and the incidence of pneumonia noted. All surviving pigs were killed on day 21 and the extent of pneumonia involvement recorded. In addition, an estimate of the actual percentage of the lung tissue with pneumonia lesions was recorded.

The mortality, lung lesion and gain data are summarized in table 4. Mortality was reduced from 50% in the non-medicated pigs to 18.9% in the pigs fed Tylan Sulfa-G (p<.01). Average daily gain for the pigs fed Tylan Sulfa-G was .508 kg. compared to .299 kg. for the non-medicated pigs, an improvement of 70%.

Of the surviving control pigs 68.8% had lung lesion involvements greater than 20% at the end of the trial as opposed to 30.8% for the group receiving Tylan Sulfa-G (figure 2). Lung lesions in all pigs that died during the trial involved 20% of the lung or greater.

Under the severe challenge imposed by this induced infection, Tylan Sulfa-G did not prevent an increase in temperature; however, the mean temperature for the treated pigs was consistently lower than that of the non-medicated control pigs. The incidence of nasal discharge and of coughs are shown in figure 3 and 4, respectively, following induction of pneumonia. The incidence of both clinical signs was reduced in the pigs fed Tylan Sulfa-G. There was a much higher incidence of coughing than nasal exudate.

Trial 2 utilized 96 healthy pigs placed in 12 rooms, eight pigs per room. Six were fed a ration containing Tylan Sulfa-G and 6 groups were fed the same ration without medication. The rations were fed for 28 days then three groups from each ration type were sacrificed. The remaining three groups fed Tylan Sulfa-G were switched to the non-medicated ration. These and the three remaining groups on the non-medicated feed were maintained for an additional 28 days. Pneumonia was induced on the third day of trial, as before.

The lung lesion and performance data are summarized in table 5. Lung lesions scores were significantly lower in the Tylan Sulfa-G than the non-medicated pigs. In the non-medicated pigs killed three weeks after the pneumonia was induced 13.2% of the lungs were infected compared to 7.3% for the Tylan Sulfa-G medicated pigs. After the 28 day withdrawal the remaining non-medicated pigs showed 25.4% of lung with lesions while in the pigs previously treated with Tylan Sulfa-G the lung involvement was 3.6%.

Average daily gain (ADG) and the feed to gain ratio was better in pigs fed Tylan Sulfa-G than the non-medicated feed. This improvement in ADG and feed to gain was evident in both the medication period and after the 28 day withdrawal.

Tylan Sulfa-G was also evaluated in two Canadian field trials. Growth performance of starter pigs from herds with a history of bacterial pneumonia was measured.

A total 144 pigs with an average initial weight of 8 kg. were utilized in the 28 day trials. There were four pens on each treatment at each location. At the completion of the trials 112 pigs were sacrificed and the lungs examined for gross and microscopic lesions suggestive of bacterial pneumonia.

The results of these two trials are shown in table 6. Although both trials were conducted with pigs from herds having histories of chronic bacterial pneumonia the disease incidence was low. In both trials average daily gain and feed to gain ratios were significantly better in pigs fed the Tylan Sulfa-G medicated feed than those fed the non-medicated feed.

Due to the high concern about the relatively high incidence of violative residues of sulfanamide drugs, that is, exceeding .1 parts per million (ppm) in the liver of pigs; Elanco has developed a new granulated sulfamethazine formulation and has incorporated it in Tylan 50 Sulfa-G Premix. The granulated sulfamethazine formulation referred to as Granurolls® greatly reduces the potential for unintentional carryover of sulfamethazine into succeeding batches of feed while maintaining bio-equivalency and product stability (shelf-life) equal to the previously marketed powdered sulfamethazine product.

Studies evaluating physical handling properties of premixes containing sulfamethazine as Granurolls elliptical pellets (homogeneity and segregation) suggest these properties are excellent and are equal or superior to those of sulfamethazine powder.

Bioavailability studies also showed that the two sulfamethazine formulations are equal in the rate of absorption and the relative degree of absorption.

Feed mill cross contamination studies were also done to evaluate Granurolls vs powdered sulfamethazine. The results of studies done at two different mills are shown in figures 5 and 6. Comparison of the average sulfamethazine content of batches two and five (first non-medicated feeds following medicated feeds) for the two trials shows the Granurolls elliptical pellets reduced cross contamination by 56% in mill one and by more than 50% in mill two.

In summary, Tylan Sulfa-G is an effective agent to be used in preventing swine pneumonia caused by Pasteurella multocida and Corynebacterium pyogenes when Tylan and sulfamethazine are each fed at 110 g/tonne of ration. The new granulated sulfamethazine formulation referred to as Granurolls greatly reduces the potential for carryover of sulfamethazine into succeeding batches of feed while maintaining bioequivalency and product stability.

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Sampson, G.R., R. F. Bing, H. P. Grueter, E.E. Ose and M. Havens, 1973. Effect of tylosin and sulfamethazine on naturally-occurring bacterial pneumonia in swine. Vet. Med./Small Animal Clin. 68:543-544.

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TABLE 1

TYLAN SULFA FOR THE PREVENTION OF LABORATORY-INDUCED BACTERIAL PNEUMONIA

Treatment	Avg. gain/ pig (kg) for 21 days	No. died/ No. in group		No. with pneumonia lesions/No. in group	
Control	1.68	19/71	26.8%	37/71	52.1%
Tylan Sulfa	5.76[b]	4/72[a]	5.6%	19/72[b]	26.4%
% Improvement	+343		79.1		49.3

[a] Significantly different from controls, P<.05

[b] Significantly different from controls, P<.01.

TABLE 2

PREVENTION OF LABORTORY-INDUCED BACTERIAL SWINE PNEUMONIA WITH TYLAN AND SULFA

Treatment	Mortality (No. dead/ No. treated)	Weight gain (Kgs./pig)
Control	17/30	-1.32
Tylan (110 ppm)	14/30	+2.99
Sulfamethazine (110 ppm)	15/30	- .408
Tylan Sulfa (110 ppm each)	10/30	+1.18

TABLE 3

EFFICACY OF TYLAN SULFA (110 GRAMS/TONNE EACH) IN NATURALLY-OCCURRING BACTERIAL SWINE PNEUMONIA

Trial	Treatment	Mortality (No. dead/ No. in group)	Weight gain (kgs.)	Feed efficiency (kgs. feed/ kgs. gain)
1	Control	4/21	10.64	2.74
	Tylan Sulfa	3/21	11.49	2.38
2	Control	5/36	11.47	2.92
	Tylan Sulfa	1/36	13.52	2.51
3	Control	7/28	11.68	3.49
	Tylan Sulfa	1/28	12.50	3.31
4	Control	0/26	7.90	2.52
	Tylan Sulfa	1/26	9.14	2.37
Totals and Averages:				
	Control	16/111 = 14.4%[a]	10.43[a]	2.92[a]
	Tylan Sulfa	6/111 = 5.4%[b]	11.66[b](+11.8%)	2.64[b](+9.6%)

[a,b] Significant difference between treatments, $P<.05$.

TABLE 4

EFFECT OF TYLAN SULFA-G ON MORTALITY, PNEUMONIC LUNG LESIONS AND GAIN FOLLOWING INDUCTION OF PNEUMONIA

Treatment	No. died/ No. in group	% of lung with lesions (number of surviving pigs)					Average daily gain (kg)[b]
		0-1%	1-5%	6-20%	7-20%	Actual %[a]	
Non-Medicated Control	16/32(50%)[c]	0	2	3	11	34.4	0.299
Tylan Sulfa-G 110 g/tonne	6/32(18.9%)	3	4	11	8	19.2	0.508

---

[a] Mean percent of lung tissue with pneumonia lesions for all survivors from one treatment.

[b] Average gain for surviving pigs for the three-week period from time of pneumonic lung challenge until termination.

[c] Significant difference between treatments, $P < .01$.

TABLE 5

EFFECT OF TYLAN SULFA-G ON PERFORMANCE AND LUNG LESIONS FOLLOWING INDUCTION OF PNEUMONIA

	7 - 28 days			29 - 56 days		
Treatment	% lung with lesions	ADG	F/G	% lung with lesions	ADG	F/G
Non-Medicated Control	13.2[a]	0.28	2.817	25.4[a]	0.495	2.747
Tylan Sulfa-G 110g/tonne each	7.3[b]	0.34	2.625	3.6[b]	0.553	2.611

[a,b] Values with different superscripts are significantly different, $P<.05$.

TABLE 6

INDIVIDUAL TRIAL RESULTS AND TREATMENT MEANS OF CANADIAN FIELD TRIALS WITH TYLAN SULFA-G IN STARTING PIGS

	ADG (kg).		Average daily feed (kg).		Feed/gain	
Trial	Control	Tylan Sulfa	Control	Tylan Sulfa	Control	Tylan Sulfa
1	0.39	0.48	0.83	0.96	2.11	2.02
2	0.28	0.35	0.50	0.61	1.79	1.70
Mean	0.34	0.42**	0.67	0.78**	1.95	1.86*
% Dif.	+23.5		+16.4		-4.6	

* $P<.05$

** $P<.01$.

Figure 1

Enhancement of Tylan® with Sulfamethazine
Against Pasteurella multocida

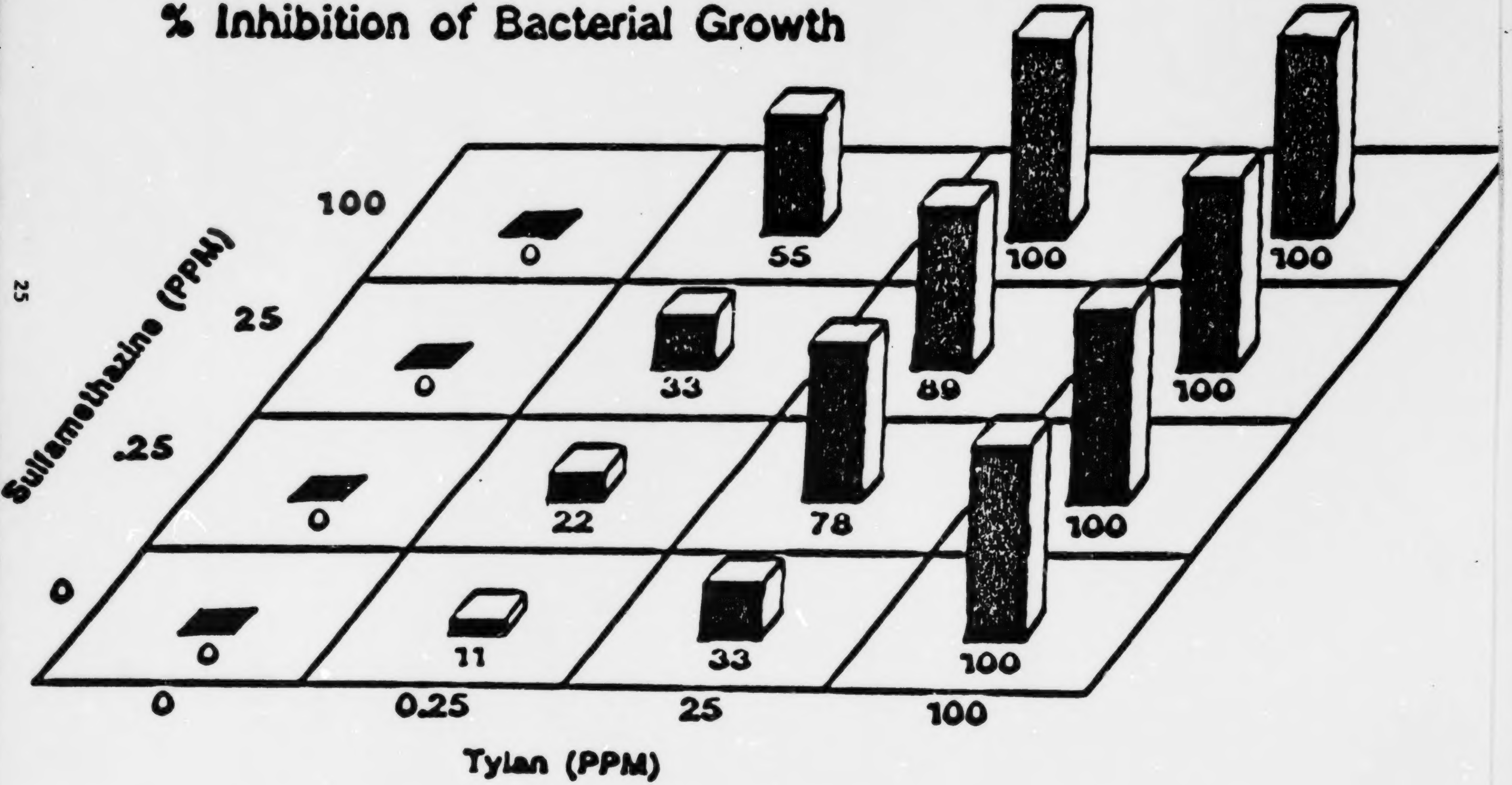


FIGURE 2. LUNG LESION INVOLVEMENT

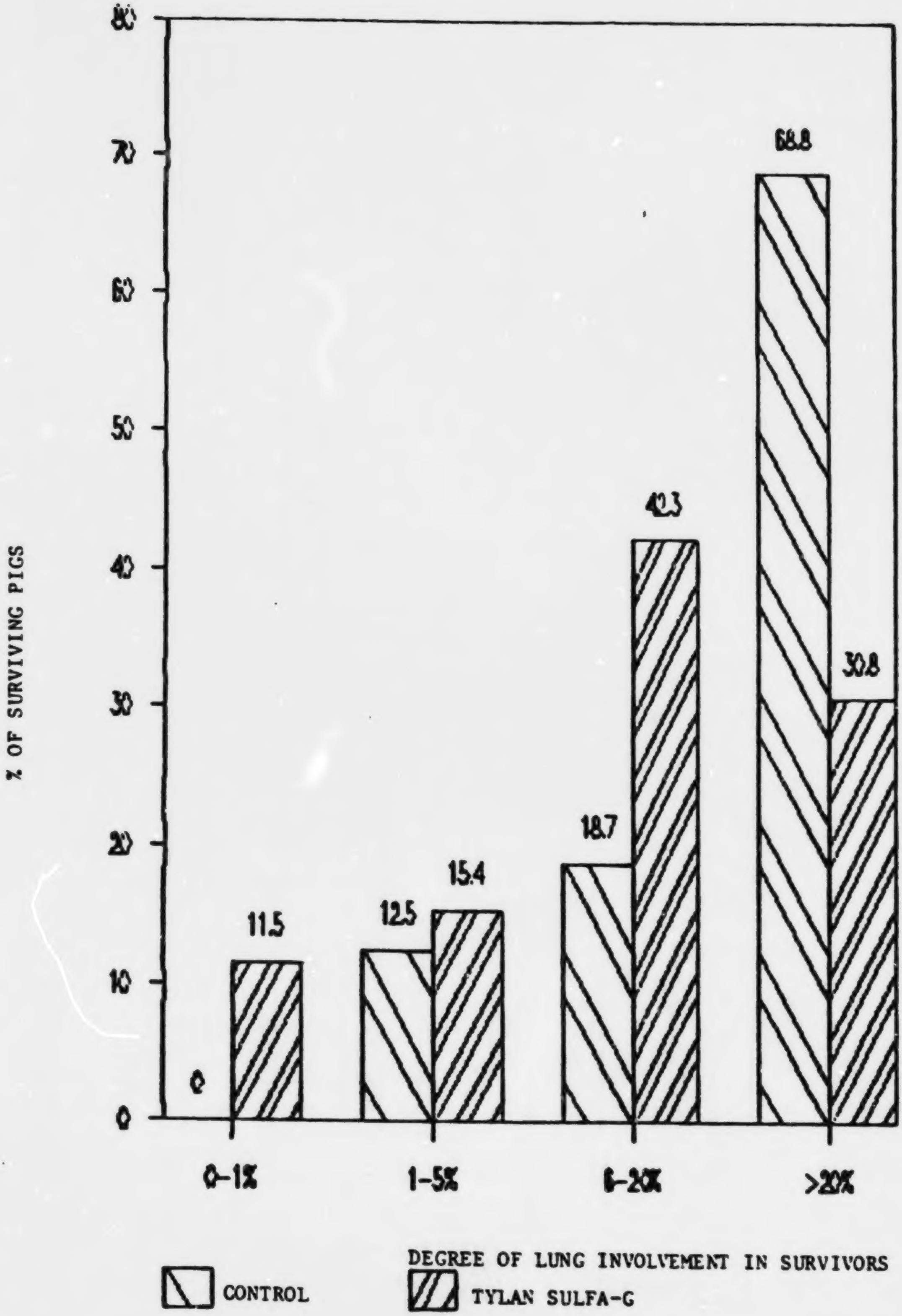


FIGURE 3. NASAL DISCHARGE

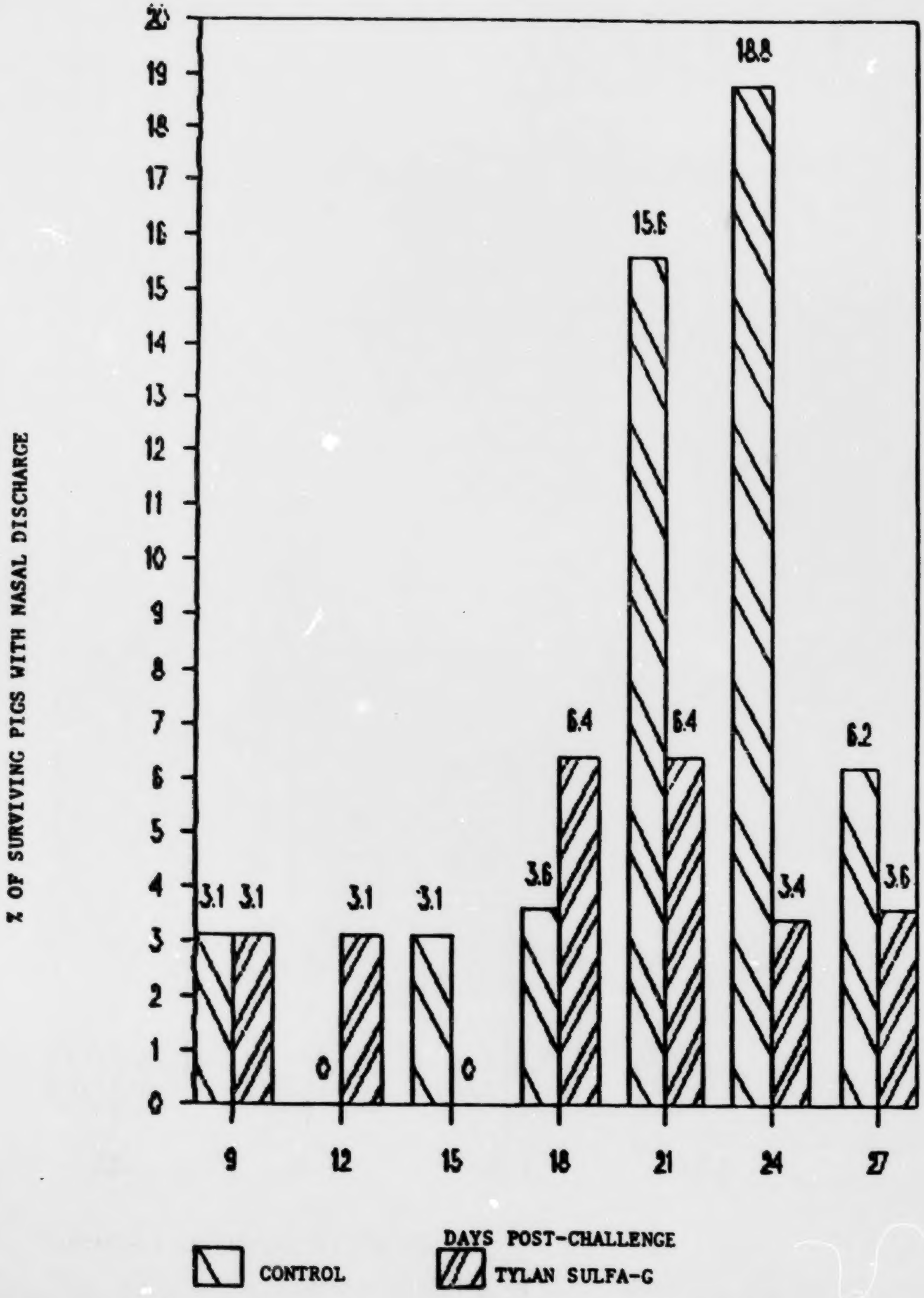


FIGURE 4. INCIDENCE OF COUGHS

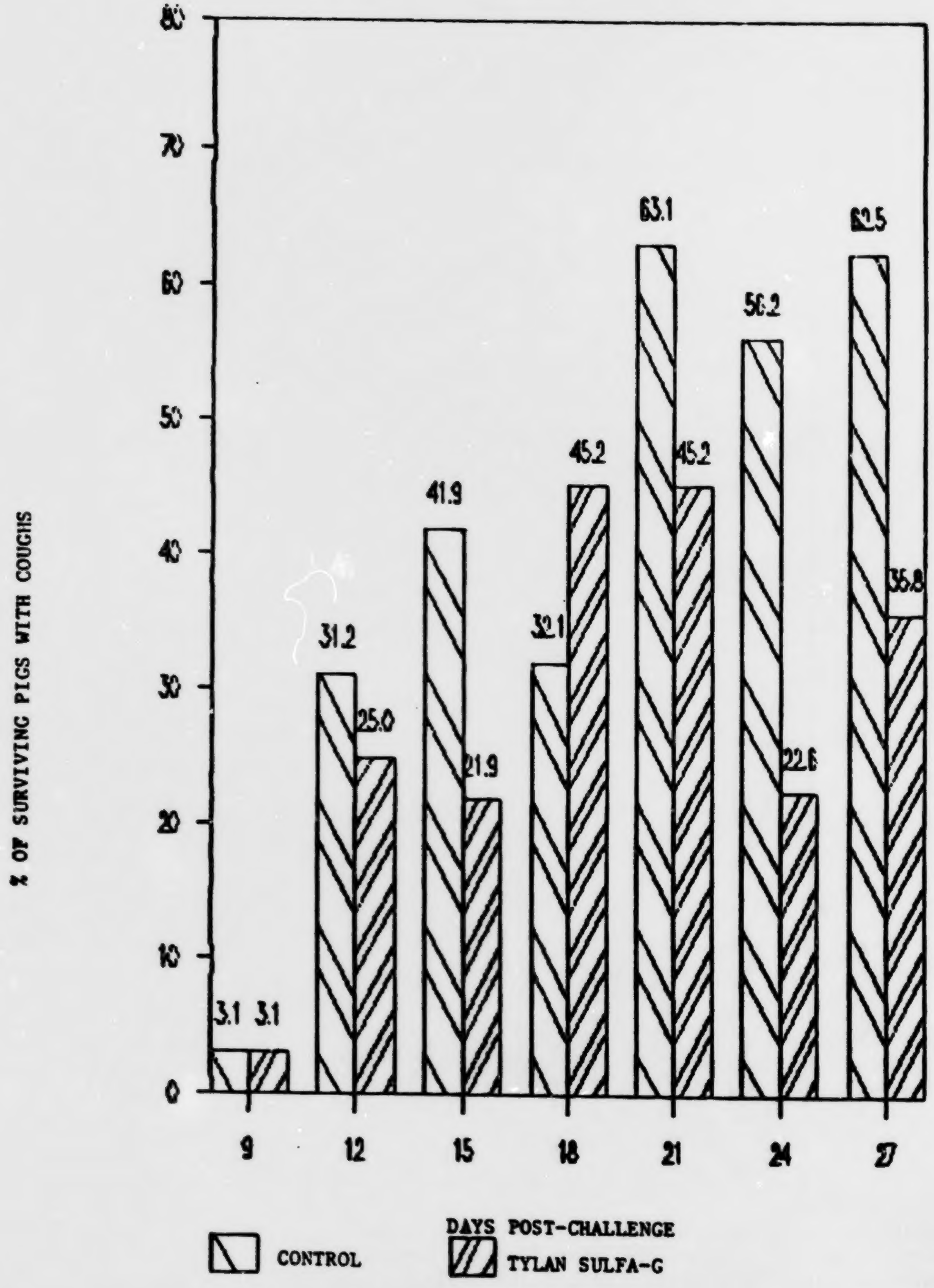
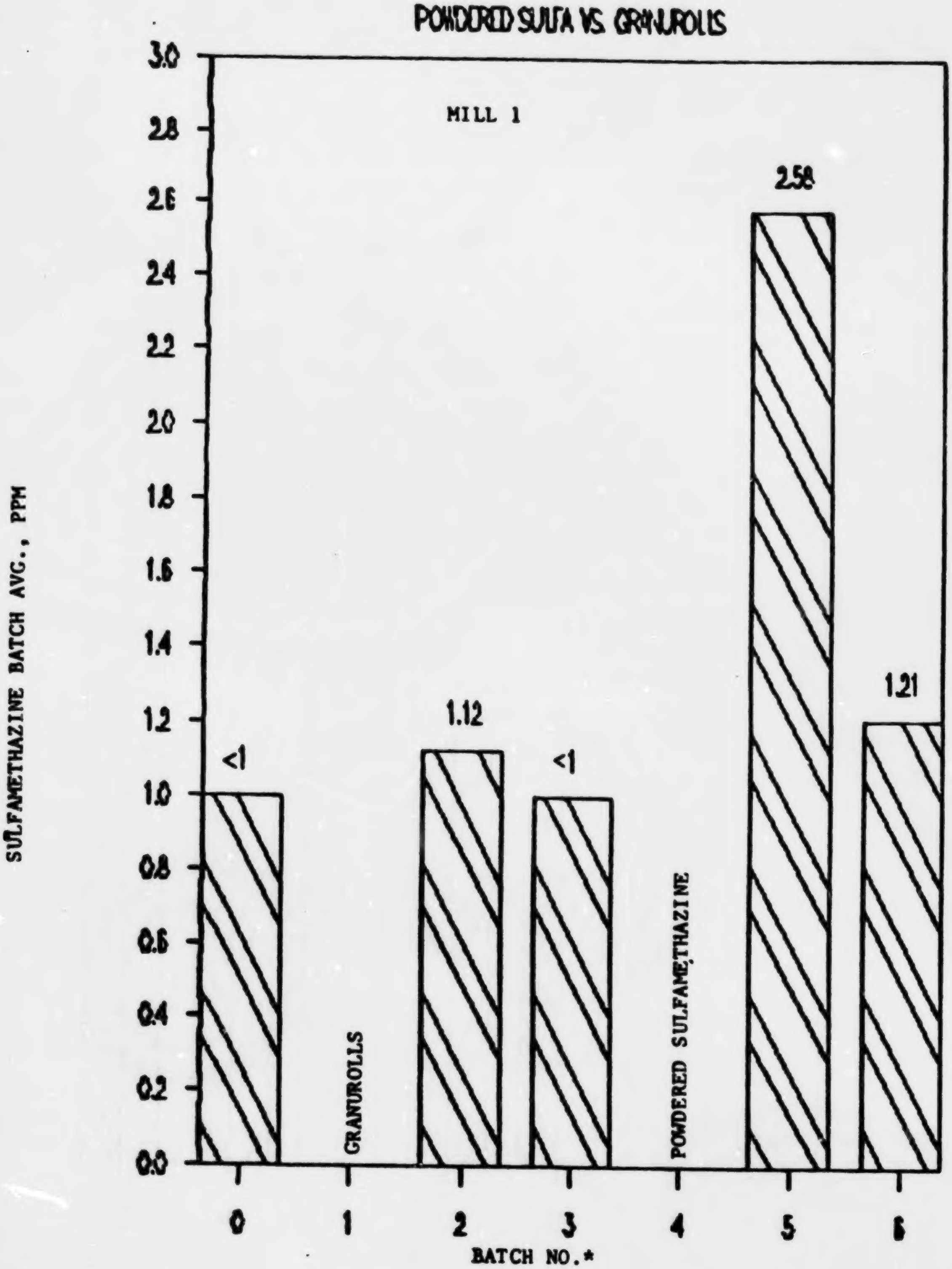
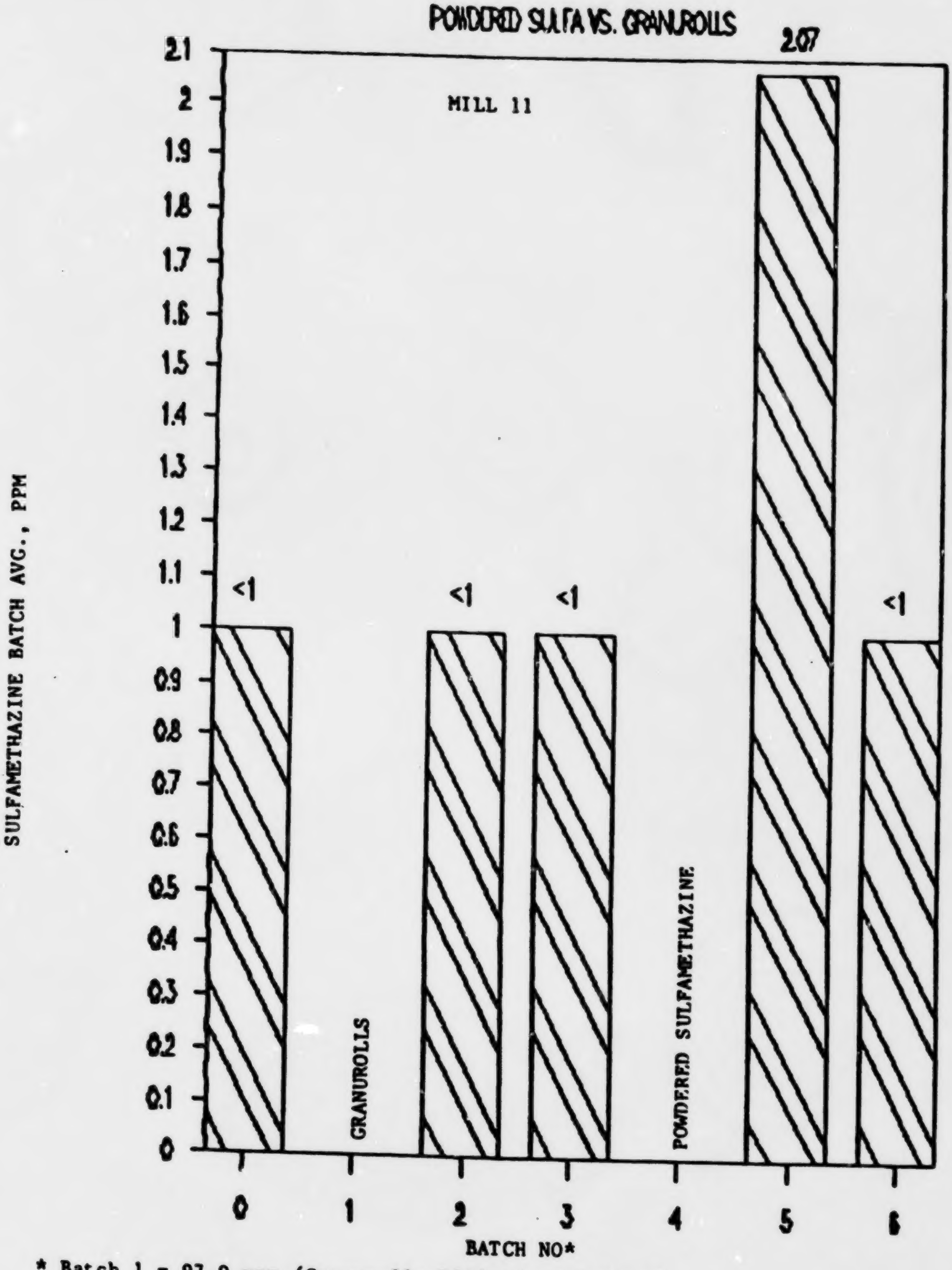


FIGURE 5. SULFAMETHAZINE PERSISTENCE



* Batch 1 = 103.5 ppm (Granurolls Elliptical Pellets)
Batch 2 and 3 = first nonmedicated after Granurolls
Batch 4 = 122.5 ppm (Powdered Sulfamethazine)
Batch 5 and 6 = first nonmedicated after Powdered Sulfamethazine

FIGURE 6. SULFAMETHAZINE PERSISTENCE



* Batch 1 = 97.9 ppm (Granurolls Elliptical Pellets)
Batch 2 and 3 = first nonmedicated after Granurolls
Batch 4 = 100.4 ppm (Powdered Sulfamethazine)
Batch 5 and 6 = first nonmedicated after Powdered Sulfamethazine

IMMUCOX
Coccidiosis Prevention By Vaccination

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Cyanamid Canada Inc.

Introduction

IMMUCOX* is the first coccidiosis vaccine for chickens and turkeys commercially available in Canada.

This oral vaccine provides a dose of oocysts that stimulates the immune system of the bird against coccidiosis. IMMUCOX can be administered to all categories of birds which are potential victims of this disease, including all chickens and turkeys used in commercial production.

IMMUCOX is an alternative to the inclusion of coccidiostats in feed. It offers long term protection against coccidiosis by stimulating the natural defense mechanism of the bird. It is a worry-free preventative once the vaccination has been completed. It is a natural means of protection that requires neither a withdrawal nor leaves residues in the carcass.

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* Registered trade mark of Cyanamid Canada Inc.

TABLE OF CONTENTS

Page

Introduction 1

Supplementary Index of Tables / Diagrams 3

1. Coccidiosis

   i) Most Important Species 4
   ii) The Development Cycle 6
   iii) Some of the Damage Caused by Coccidia 8
   iv) Results of the Damage 8
   v) Immunology and Coccidiosis 9

2. Diagnosis

   i) Steps to Follow 12
   ii) Misdiagnosis 14

3. Reported Side Effects of Anticoccidial Drugs 16

4. IMMUCOX

   i) The Product 18
   ii) Label 20

SUPPLEMENTARY INDEX OF TABLES / DIAGRAMS

Page

Fig. 1. Life cycle of *Eimeria tenella* 7

Fig. 2. Key to identifying coccidia lesions 13

Table 1. Some reported side effects of anticoccidial drugs 16

1. COCCIDIOSIS

Coccidiosis has long been recognized as a disease that causes great economic loss to the poultry industry. Reduced growth rate, poor feed utilization and mortality are common effects.

A one-celled protozoa called a coccidium is responsible for the disease. These parasites of the genus Eimeria are host specific and thus species that infest chickens will not infest turkeys or other birds or mammals.

Several species of Eimeria cause coccidiosis in poultry and they all have short and direct life cycles. The coccidia economically important to poultry cause damage in the epithelial cells in the intestinal tract.

1) The most important species are:

(A) Eimeria tenella - very pathogenic, causes bloody cecal coccidiosis and often mortality.

(B) E. necatrix - very pathogenic, causes bloody intestinal coccidiosis and often mortality.

(C) E. maxima - not as pathogenic as E. tenella, but capable of causing weight loss and some mortality.

(D) E. acervulina - considered less pathogenic than the previous three species. This very common species reduces weight gain and impairs the absorption of important nutrients and pigments.

(E) E. mitis - difficult to diagnose because it does not cause distinct lesions and the oocysts cannot be distinguished from those of E. acervulina or E. tenella. Heavy infections can cause weight loss and impair absorption of nutrients.

(F) E. brunetti - difficult to diagnose because of the indistinct lesions in the lower intestinal tract. It may be very pathogenic, causing weight loss and mortality.

(G) E. mivati - the existence of this species is uncertain at this time.

The differentiation of coccidial species is based on the location and appearance of lesions and the presence of life-cycle stages observed under the microscope.

ii) The Development Cycle

Unlike bacteria and many other one-celled organisms, coccidia have a very definite pattern of development. There are two or more generations of asexual development known as schizogony, followed by a sexual phase (gametogeny) which results in the formation of oocysts. The oocysts are excreted in the droppings and become infective in the poultry litter only after sporulation during which sporozoites are produced. The sporulation process takes approximately one day. Thus, the stages in the life cycle of the coccidia are (see Fig. 1):

(1) sporozoites (the motile infective stage);

(2) schizonts (the multiplying asexual reproductive stages);

(3) merozoites (the second- or third-generation motile infective stages developed in the schizonts);

(4) gamonts or gametocytes (the sexual reproductive stages);

(5) oocysts (zygotes formed by the sexual union of the macrogamete and the microgamete). Oocysts may be unsporulated (immature, consisting of a single cell - uninfective) or sporulated (containing sporocysts and sporozoites - infective).

Reproduction of the parasite does not continue indefinitely because of the nature of the coccidia and the resultant acquired immunity or death of the host. The infection, without medication, will terminate if the infection is not severe enough to kill the bird.

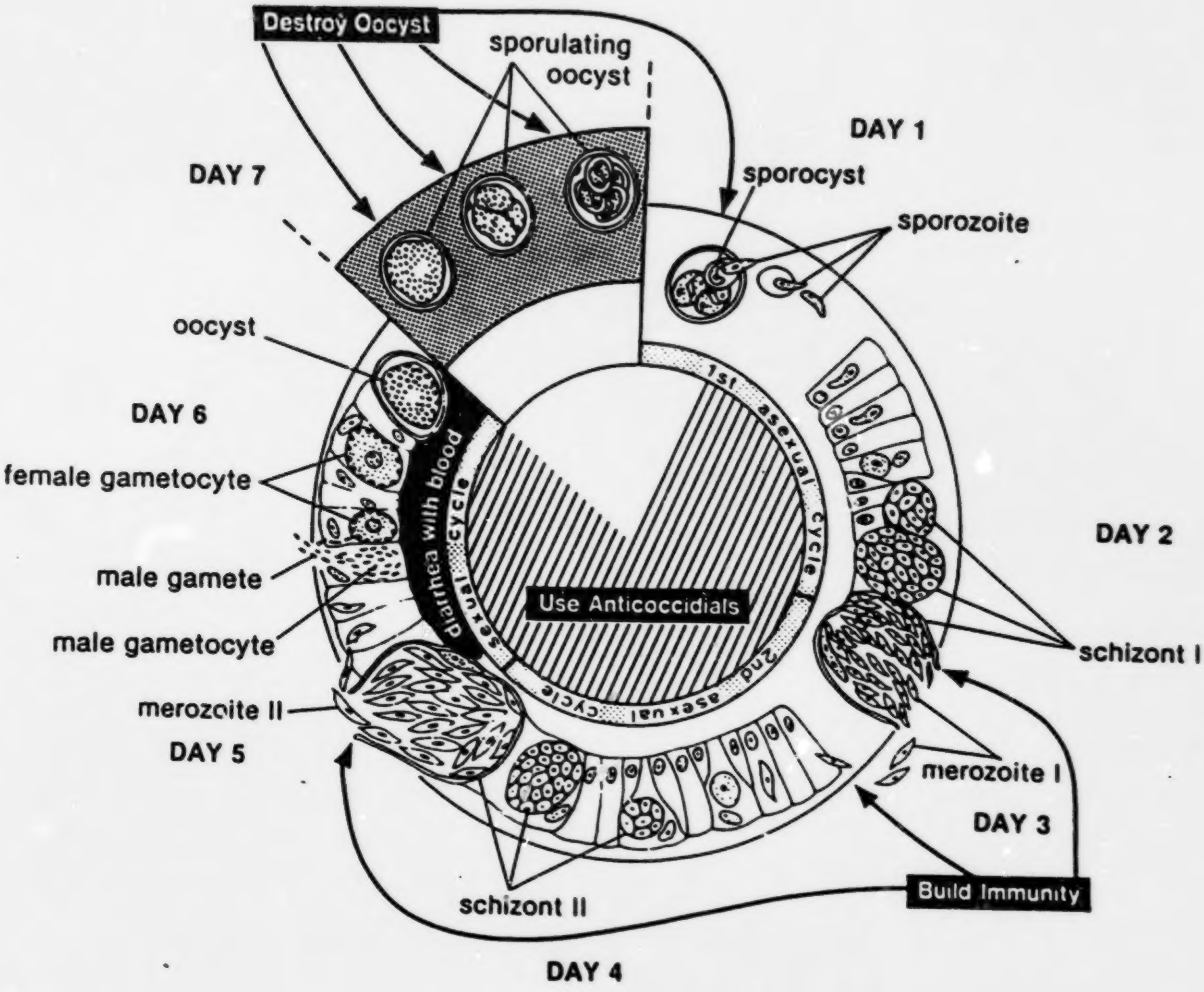
Destroy Oocyst
sporulating oocyst
DAY 1
DAY 7
sporocyst
sporozoite
oocyst
DAY 6
female gametocyte
male gamete
male gametocyte
merozoite II
DAY 5
diarrhea with blood
sexual cycle
1st asexual cycle
2nd asexual cycle
Use Anticoccidials
DAY 2
schizont I
merozoite I
DAY 3
Build Immunity
schizont II
DAY 4

Fig. 1. Life cycle of *Eimeria tenella*

(Source: 'A Guide for the Diagnosis of Coccidiosis in Chickens'
by Peter L. Long & W. Malcolm Reid)

iii) Damage Caused by Coccidiosis: Losses from coccidiosis may take many forms. Because of the location of the parasite, all damage is directly or indirectly the result of changes of the intestine.

Some of the damage caused by coccidia includes:

- fluid loss because of diarrhea
- loss of blood proteins and cells
- reduced absorption of nutrients and vitamins

iv) Results of the damage:

- impaired feed efficiency
- reduced weight gain
- lack of uniformity
- mortality

The effects of coccidiosis on nutrient utilization may lead to muscular dystrophy and leg problems.

Eimeria acervulina and *E. tenella* can produce marked effects on weight gains and feed conversion ratio.

A perfectly formulated diet fed to a infected bird will do little good if the bird is unable to absorb and utilize the nutrients properly.

A simple key (Fig. 2) permits a quick identification of species of *Eimeria*.

v) Immunology & Coccidiosis

Immunity is the result of the body producing an internal defence system which can prevent the invasion of, or can counter attack an infection by disease-causing organisms such as bacteria, viruses or protozoa.

The immune system is made up mostly of an "army" of cells called lymphocytes. These lymphocytes are of 2 types: T cells from the thymus and B cells from the bursa of Fabricius.

The cells are non specialized but once they encounter an organism (antigen), they not only concentrate specifically against that particular invader; but, replicate to increase in numbers, improving the defence. They also form "memory" cells that remain in circulation and can be mobilized to protect should there ever be another attack by the same organism.

The B cell function is to produce antibodies. These antibodies are soluble proteins which combine with the invading organism or antigen (or part-of-it) to inactivate it.

B Lymphocyte + Antigen

Replicates into more B cells	Soluble protein (Antibody)	Memory Cells
- specifically directed against that antigen	to contain and neutralize that antigen	remain in circulation for prolonged periods of time. Respond immediately the next time that antigen is encountered.

The T cell function is to respond to cells that are abnormal, i.e. not recognized as part of normal "self", for example, intestinal cells infected by viruses or cancer cells. A T cell, upon encountering an abnormal cell specializes into a T killer and T effector cells, replicates and produces "memory" cells. The T killer cell destroys abnormal cells by releasing toxic enzymes.

Replicates into more T cells specifically directed against that cell type.

T Killer Cell
produces toxic factors to kill the abnormal cell.

T Lymphocyte. & Abnormal Cells

T Effector Cell
releases substances that aid the T killer cell.

Memory Cells
remain in circulation for prolonged periods of time
respond immediately the next time that organism is encountered.

By examining the life cycle diagram of coccidiosis in chickens, (see above chart) you can see that there are both lymphocyte systems involved in immunity against coccidiosis.

Firstly, sporozoites invade the surface cells lining the intestinal walls. These infected cells are changed and recognized as abnormal; therefore the cell mediated immune response of T Killer cells is stimulated. Next, during the asexual phases, schizonts and merozoites are released locally into tissues before they invade cells to further replicate. In doing so, they stimulate the B cell system to produce antibodies against these organisms.

Finally, the sexual phase of the life cycle invades the surface lining cells of the intestinal tract, again stimulating a T cell immunity. This last phase appears to induce a stronger immune protection than the earlier asexual phases.

Most coccidiostats work by inhibiting the initial asexual stages of the coccidia life cycle. In such a way, there is no cellular or tissue invasion thus no immunity develops. It is important to note that coccidiostats must be administered continuously to prevent the disease from occurring because their action does not allow immunity to develop.

IMMUCOX* is a coccidia vaccine composed of live, infective oocysts administered at controlled doses. In so doing, the oocysts form sporozoites and go through the normal life cycle thus priming the immune system and causing T & B lymphocytes to specialize, replicate, and produce memory cells. In that way, the chicks do not get the disease, but mount a defense against all stages of the coccidia life cycle. This then means that once the chick has been properly vaccinated, it has protection against coccidiosis for life.

2. Diagnosis

The economic importance of coccidiosis can easily be seen when one considers the cost of preventive medication. Additional costs include clinical and subclinical losses caused by coccidiosis outbreaks, which can occur despite the use of drugs. Further costs as measured in poorer feed conversion also can be attributed to the disease.

1) The Diagnosis of Coccidiosis

Observation of the flock and laboratory testing should be combined to confirm an outbreak of coccidiosis. The following steps should be taken:

(1) If the flock has signs of illness, look for abnormal droppings or blood in the feces. Look for birds with lethargy, ruffled feathers or in a moribund condition.

(2) Autopsy some dead and some moribund birds and look for typical gross lesions characteristic of the important species of coccidia.

(3) Confirm the association of coccidia with the lesions by microscopic examination of intestinal scrapings. Identify the developing stages of coccidia or their oocysts.

(4) Examine birds selected randomly from the flock (not just culls) to determine whether coccidiosis is common in the flock or present in only an occasional bird.

	MARKED HEMORRHAGE AND GROSS LESIONS			HEMORRHAGE *NOT* MARKED		
	deep erosion of epithelium		mucoid enteritis	mucoid/necrotic enteritis		
locations	ceca	intestine	duodenum anterior intestine	midgut	posterior intestine	posterior intestine and ceca
developmental stages seen in smears	large schizonts	large schizonts	numerous gametocytes and small oocysts	gametocytes and large yellowish oocysts	gametocytes or oocysts	gametocytes or oocysts
additional features	cecal cores containing masses of oocysts may be formed in final stages light infections may produce thickened red or greyish lesions in the gut wall without noticeable blood.	no obvious changes in ceca.	light infections produce small white discrete foci: in heavy infections, lesions coalesce and extend posteriorly along the intestine: often results in thin friable intestinal tissue. Lesions caused by. *E. mivati* may be associated with few discrete lesions but gross thickening of the intestine may occur. Late in the life cycle lesions appear more numerous in the lower gut and ceca.	severe infections may produce marked hemorrhage and necrosis.	whitish exudate and caseous masses formed in lower intestine: heavy infections may cause severe necrotic lesions.	thickening of intestinal wall. Mucoid exudate.
species	*E. tenella*	*E. necatrix*	*E. acervulina* - *E. mivati*	*E. maxima*	*E. brunetti*	*E. mitis*

Modified from Long *et al.*, 1976

Fig. 2 Key to Identifying Coccidiosis Lesions

ii) Pitfalls in diagnosing coccidiosis in commercial poultry flocks. The accurate diagnosis of coccidiosis is relatively simple, but misdiagnosis is frequent because of lack of attention to details or undue emphasis on any of the following.

(A) Appearance of gross lesions - Many intestinal diseases can be mistaken for coccidiosis even though the diseases usually do not produce lesions which look like coccidial lesions. Some of these diseases are nonspecific, necrotic, and ulcerative enteritis, intestinal capillariasis and other intestinal parasitisms, and salmonellosis. Misdiagnosis can also occur when determining the coccidial species present because mixed lesions of overlapping species may often be confusing even though lesions caused by the various species are remarkably specific. Additional information is usually necessary to make an accurate differential diagnosis.

(B) Counts of oocysts in the litter - Oocyst counts can be used in scientific studies which provide for extensive sampling at multiple sites in order to gain an over-all impression and to support or refute conclusions reached through other observations. Oocyst counts in litter cannot be used alone to diagnose an outbreak or to identify a species involved in an outbreak.

(C) Routine examination of culls or birds that have died - This can be misleading if the diagnostician does not actually visit the farm and determine whether the condition found in the dead birds is typical of the birds on the farm. Culls usually have some type of disease, but they may not represent the entire flock. Frequently, cull birds have not received their share of anticoccidial drug for several days since a debilitating disease, such as leg weakness, may have prevented them from receiving adequate feed. In such cases, coccidial lesions are common, but do not indicate a clinical infection of the entire flock.

It should be emphasized that data from cull birds can be valuable if scientifically collected and used for the right purpose. Such data, however, have limited value in the diagnosis of coccidiosis.

3. REPORTED SIDE EFFECTS OF ANTICOCCIDIAL DRUGS

In-feed coccidiostats are widely used to prevent or control coccidiosis. Water medication is also utilized, but with variable results. To be effective, coccidiostats must be added to the birds' feed continuously. A withdrawal period has to be respected when applicable. Some feed coccidiostats have been associated with efficacy problems and some have produced undesirable side effects (See Table 1).

Table 1. Some Reported Side Effects of Anticoccidial Drugs*

Anticoccidial	Reported Side Effect(s)
amprolium	Thiamine deficiency
furazolidone	Cardiomyopathy
lasalocid	Wet droppings, wet litter and associated problems
monensin	Transient paralysis of the legs, interaction with sulfur-containing amino acids, hysteria in layer pullets, poor feathering, adverse reaction in combination with tiamulin.
nicarbazin	Depressed growth, toxicity to layers, bleaching of brown eggs, reduced fertility, decreased egg production, increased susceptibility of broilers to heat stress.
robenidine	Undesirable taste in meat of chicken when dose levels are exceeded and withdrawal times are not observed.
3-Nitro	Stiff legs or paralysis in cold weather.
salinomycin	Effects similar to those of Monensin.
sulfaquinoxaline	Vitamin K antagonism, hemorrhagic enteritis.

* Adapted from Dr. L.R. McDougald University of Georgia October 1984.

0049A/3007A

All species of Eimeria are capable of developing drug resistance. Tolerance, or acquired drug resistance, has been the most important reason for the failure of anticoccidal drugs.

For the last 35 years, many developments have occurred in poultry biological products. Vaccines have been developed and applied successfully for the control of such diseases as Marek's Disease, Gumboro Disease, Newcastle Disease, Infectious Laryngotracheitis, Infectious Bronchitis, Fowl Pox and Avian Encephalomyelitis. The poultry industry quickly realized that the use of vaccination was a very important tool to use in producing healthy birds and to ensure a profitable business.

Thus the development of a new technique in coccidiosis prevention resulted in IMMUCOX coccidiosis vaccine to effectively prevent coccidiosis.

4. IMMUCOX

IMMUCOX is the first coccidiosis vaccine commercially available for chickens or turkeys in Canada. IMMUCOX stimulates the natural immune mechanism of birds against coccidiosis. This oral vaccine is designed to deliver uniform doses of live oocysts to chickens or turkeys to initiate the development of immunity against coccidiosis.

1) The Product

IMMUCOX was developed by Dr. Eng Hong Lee of Vetech Laboratories Ltd. Cyanamid Canada Inc. is the distributor of the product. IMMUCOX was tested in Canada on over one million birds before market introduction.

The mode of action of IMMUCOX is based on delivering a controlled challenge to a bird, thus causing the immune system to respond, resulting in immunity to further coccidial challenge.

The key to the effectiveness of the vaccine is the controlled dose of oocysts administered to the bird. A unique delivery method is employed to ensure a uniform exposure for the entire flock. The delivery method utilized for the vaccine mixture was developed for its ability to suspend oocysts uniformly. After the two vaccinations have been administered, no other vaccination for coccidiosis is necessary.

IMMUCOX is a biological tool for poultry producers to use in the prevention of coccidiosis. It is a new approach and introduces a "No Drug" concept of coccidiosis control.

The phenomenon of coccidia developing drug resistance is well recognized. When coccidia become drug-resistant, the control of coccidiosis can rely upon vaccination with IMMUCOX in the subsequent crops.

Furthermore, IMMUCOX does not require any withdrawal period and does not produce any tissue residues.

IMMUCOX stimulates the natural immune mechanism against the disease and ensures that no resistant strain of Eimeria will develop.

This oral coccidiosis vaccine gives flexibility to the grower. IMMUCOX could be used continually or in a rotation program with traditional in-feed coccidiostats.

Another positive aspect of IMMUCOX is the reduced handling of feed additives at the feed mill. The production schedule of a mill presently has to be organized to avoid cross contamination. With IMMUCOX to prevent coccidiosis, the feed manufacturer can reduce the milling costs of poultry feed manufacturing.

IMMUCOX poses no human health hazard to the user.

ii) IMMUCOX Label

(Logo)
IMMUCOX* vaccine
An oral Coccidiosis
Vaccine of live
oocysts of Eimeria spp.

FOR VETERINARY USE ONLY
Store in cool place (4°C)
Do not freeze

DESCRIPTION

IMMUCOX is designed for the purpose of delivering uniform doses of live oocysts to chickens or turkeys to aid in the development of immunity against coccidiosis. When applied according to the directions, IMMUCOX can prevent mortality and reduced weight gains that are attributable to coccidiosis.

PRECAUTIONS

1. Be sure that *no coccidiostat* (anticoccidial) is used in the feed. Even a low level of coccidiostat can reduce the effectiveness of the vaccine.

2. Broad spectrum antibiotics (e.g. tetracyclines) or nitrofurans, which possess anticoccidial activity, should not be present in feed or water prior to or within 12 days after vaccination.

3. Do not over dose or under dose.

DIRECTIONS FOR THE PREPARATION OF IMMUCOX VACCINE:

1. Be sure that you have available a sufficient quantity (doses) of IMMUCOX vaccine and the coresponding amount of diluent. (One vial of vaccine plus one package of dry diluent per 1,000 birds.)

2. Add approximately one litre of tap water to the "Diluent Mixing Container" so as to half fill the two-litre container.

3. Add one package of "IMMUCOX Diluent" to the "Diluent Mixing Container" which now contains one litre of water. Mix thoroughly by shaking the plastic container vigorously.

4. Pour one vial of IMMUCOX vaccine into the mixed diluent and add water to the two-litre level. Shake the mixture vigorously.

5. The vaccine mixture is properly mixed when the colour appears uniform. The mixture will be green for chickens and red for turkeys.

ADMINISTRATION:

1. Vaccinate healthy birds at 4 to 6 days of age.

2. Withdraw water from the birds for 1 to 2 hours prior to vaccination. Be sure that no water from any source is available to the birds during vaccination.

3. Before the vaccine mixture is administered, remove all solid matter, debris and water from the drinkers.

4. Pour the vaccine mixture directly into all the drinkers in use: (a) Water troughs - use all troughs; (b) Bell-shaped drinkers - use at least 1 drinker per 300 birds; (c) Swish cups - pour into all drinkers and refill as required. Be sure to use ***all the predetermined amount of the vaccine mixture.***

5. Resume normal watering when no vaccine mixture remains in the drinkers (approximately one hour).

6. Repeat the above procedure 3 days after the first exposure.

CAUTION

The capacity of IMMUCOX to aid in the development of immunity against coccidiosis depends on many factors. These include, but are not limited to: conditions of storage and handling of the vaccine by the user, the method of administration of the vaccine, the responsiveness of individual birds to the vaccine and whether the directions for use and precautionary measures are followed carefully. If the capacity of the vaccine is affected by one of these factors, excessive morbidity and mortality may occur. If mortality exceeds 0.5% during a two day period consult a poultry veterinarian or a diagnosic laboratory. Inform the veterinarian or the diagnostic laboratory that the flock has been vaccinated with IMMUCOX.

AVAILABILITY

IMMUCOX Chicken: ***Eimeria acervulina, E. maxima, E. necatrix, E. tenella.***

IMMUCOX Turkey: ***Eimeria meleagrimitis, E. adenoeides.***

Note: Upon veterinary request:
1) IMMUCOX chicken can be produced to add any or all of the following species: ***Eimeria brunetti, E. mivati*** and/or ***E. praecox.***
2) IMMUCOX turkey can be produced to add ***Eimeria gallopavonis.***

Manufactured By: Vetech Laboratories Ltd.
R.R.4 Rockwood, Ontario
NOB 2KO

Distributed By: Cyanamid Canada Inc.
2255 Sheppard Ave. East
Willowdale, Ontario
M2J 4Y5

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* Trade Mark of Cyanamid Canada Inc.
0049A/3007A

NON - STRUCTURAL CARBOHYDRATE
Concept for Formulating Dairy Feeds

Bernie Grumpelt
Federated Co-operatives Limited

Building on Research and Experience

BND Dairy Rations

BND (Balanced Nutrient Density) Dairy Rations are special lines of CO-OP feeds that have been specifically balanced for all nutrients. This includes energy, protein, macro minerals (such as calcium and phosphorous), minor minerals (sometimes called trace minerals, such as copper and zinc), and vitamins. CO-OP BND Dairy Rations are research proven to give you the most for your feed dollar. The increased efficiency you get with these feeds means you receive maximum returns on your feed investment. To ensure that BND feeds are the best on the market today, the research continues. Whenever a new discovery is made, the research findings are included in the formulation for BND Dairy Rations. The latest improvement to these feeds is explained in the following report.

Continuing Research is the Answer

In 1979 CO-OP FEEDS introduced to you the CS (Controlled Solubility) line of Dairy Rations. These dairy rations were based on the concept of Regulated Protein Solubility. This concept helped significantly increase the average production of cows. For cows consuming Regulated Protein Solubility feeds, increases of up to 11 lb./cow/day were documented in the U.S.A. This was accomplished with no increases in feeding rates or protein levels.

Protein for dairy cows can be classified in two basic categories:

1. Soluble - readily broken down by bacteria
2. Insoluble - more slowly broken down by bacteria

Solubility is an estimate of the amount of feed protein that is converted to ammonia by microbes in the rumen. Soluble protein is used as the primary nitrogen source of the rumen microbes. These microbes are then used by the cow to supply some of her protein needs. The insoluble protein is not readily broken down into ammonia by the microbes and, therefore, larger quantities "escape" or "by-pass" digestion in the rumen. Depending upon the source and quality of the protein, large portions of the protein can "by-pass" digestion in the rumen and become available to the cow further down the G.I. tract. Both forms of protein must be supplied to the cow in the proper amounts to meet the total protein needs of the high-producing dairy cow.

At the Co-operative Research Farm, milk production was measured in a trial (CRF304) in which cows were divided into evenly balanced groups of twenty and fed rations containing different levels of soluble and insoluble protein. The group fed the rations containing the higher levels of insoluble protein (by-pass protein) produced significantly more milk (6.1 lb./cow/day) than the cows fed the normal solubility grain mix.

Effect Of Regulating Protein Solubility
On Milk Yield Of High Producing Cows

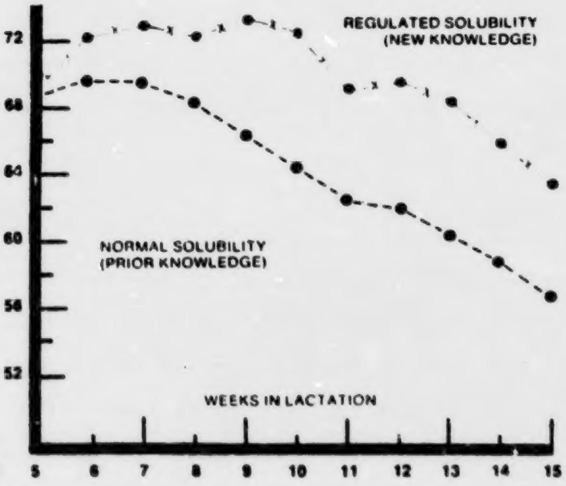


Fig. 1

The results are shown in Figure #1 on page 2, which clearly indicates the increased production. It is important to remember that both had the same total protein, energy, mineral, and vitamin content. The only real difference was in protein solubility. The cows receiving the higher levels of insoluble protein produced more milk, peaked higher, and had better persistency! Also, milk fat percent was maintained at the higher production levels with the control cows at 3.75% and the cows on the higher level of insoluble protein at 3.70%.

Continuing Research Breeds Success

The sole reason for the existence of the Co-operative Research Farms is to provide our customers with the best in products, service, and knowledge. After being the first to introduce Regulated Protein Solubility feeds, we knew that we had made a major step ahead in dairy nutrition. We also knew that we did not yet have the total answer. We knew that to feed a dairy cow, we must first feed the rumen microbes. This is where we placed our research efforts. The answer seemed to be balancing rations so they would supply enough protein, energy, minerals and vitamins to feed the rumen microbes first, and then feeding the cow - giving them both the proper levels of each nutrient. To prove this theory, we investigated the Non-structural Carbohydrate concept of balancing feeds.

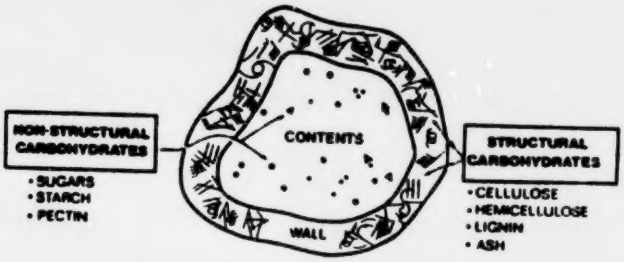
What are Non-structural Carbohydrates?

Before outlining what Non-structural carbohydrates are, a quick review of some basic facts about ruminant nutrition is necessary.

Rumen microbes require readily available energy (carbohydrates) to use the ammonia produced when soluble protein is broken down. Energy is the major nutrient required by the cow. It is supplied mainly in the form of carbohydrates and only water is required in larger amounts. For years rations have been balanced for 'structural carbohydrates' (better known as fibre). However, all carbohydrates and fibre are not the same. For a properly balanced ration dairy cows need specific amounts and types of carbohydrates to meet their energy requirements.

What are Carbohydrates?

Carbohydrates are chemical compounds consisting of carbon, hydrogen, and oxygen. In plants, there are two forms of carbohydrates as illustrated below:



The plant cell walls are commonly referred to as neutral detergent fibre (NDF).

The plant cell walls are commonly referred to as neutral detergent fibre (NDF).

Due to the rumen microbial population, the rumen has the unique ability to digest large amounts of structural carbohydrates. The ruminant, in turn, supplies us with food and clothing.

Structural
Carbohydrates — Food (Meat + Milk)
+
Simple Proteins — And
+
Non-Protein — Clothing (Wool)
Nitrogen

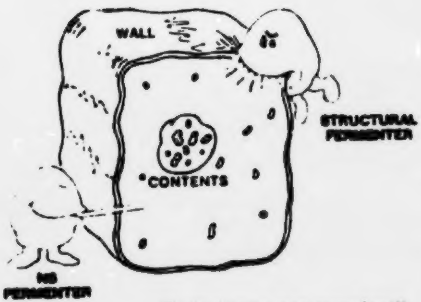
Digestibility by rumen microbes is the major difference between Nonstructural and Structural Carbohydrates. Non-structural carbohydrates are quickly and easily digested by the microbes; structural carbohydrates are designed more slowly. The amount of structural carbohydrate that is digested by the rumen microbes depends primarily upon the lignin content of the cell walls. As the lignin content increases, the digestibility decreases.

Generally speaking, structural carbohydrates are a negative indicator of ration energy concentration: as structural carbohydrates increase, energy concentration decreases. Present energy systems used to formulate rations for dairy cows are based on this inverse relationship between structural carbohydrates and energy concentration.

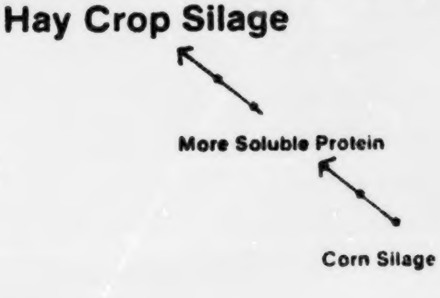
The availability (digestibility) of forage carbohydrates is strongly influenced by:

1. Plant variety
2. Maturity at harvest
3. Storage conditions

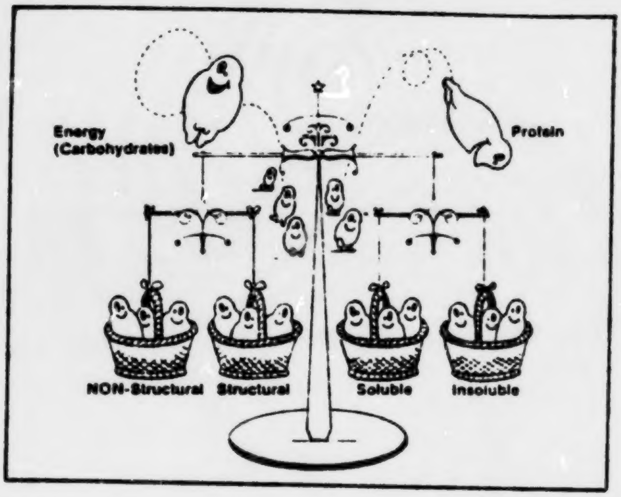
Grains, on the other hand, have higher levels of non-structural carbohydrates and the amount is much less variable than in forages. Increased feed efficiency (more pounds of milk per pound of feed) can be obtained by regulating the amount of non-structural carbohydrates in the ration.


WALL
CONTENTS
STRUCTURAL FERMENTER
NS FERMENTER

Both types are required!


Hay Crop Silage
More Soluble Protein
Corn Silage

With hay crop silage, more non-structural carbohydrates are required to efficiently use the soluble protein. As illustrated below, proper balances of both types and aounts of carbohydrates and protein are required.


Energy (Carbohydrates)
Protein
NON-Structural
Structural
Soluble
Insoluble

For optimum efficiency: the non-structural and structural carbohydrates must be balanced; the soluble and insoluble protein must be balanced according to the levels of non-structural carbohydrates; and the energy (carbohydrates) must be balanced with the available protein.

If there is too much non-structural carbohydrates, there will be:
1. too much rumen acid;
2. reduced fibre digestion;
3. reduced feed intake; and
4. lower milk fat percent.

If there is not enough non-structural carbohydrate, there will be:
1. not enough energy;
2. lower milk production;
3. higher fibre ration; and
4. reduced feed intake.

If there is too much soluble protein, there will be:

1. too much for the microbes to use;
2. inefficient use of protein;
3. not enough insoluble (by-pass) protein; and
4. reduced milk production.

If there is not enough soluble protein, there will be:

1. lower microbial growth and yield;
2. lower fibre digestion;
3. lower feed intake; and
4. reduced milk production.

Non-structural Carbohydrate Balanced Feeds

There's nothing like it!

Only CO-OP Feeds, in conjunction with the Co-operative Research Farms, is able to bring this new technology to you! With this patented (pending) procedure, we are able to balance rations to supply the proper level of energy in the proper forms, the right amounts of soluble and insoluble (by-pass) protein, as well as the proper levels of minerals and vitamins to maximize the productive efficiency of your cows. The concept is simple: maximize the rumen microbial production and you will get more from every mouthful the cow eats.

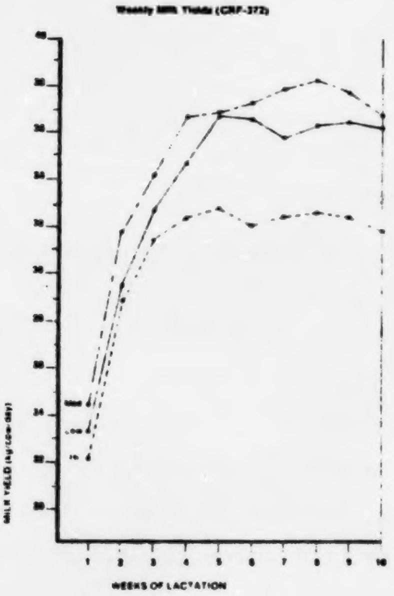
The experiments prove the theory.

In the first experiment (CRF-372), 45 cows that were beginning their second or more lactation were blocked according to production levels and assigned one of three treatments: low, medium, or high levels of non-structural carbohydrates (NSC). The results are shown in the following figure:

The effect of low, medium or high levels of NSC on production parameters of multiparous cows from the first to the tenth week of lactation.

Variable	Low NS	Med NS	High NS
Cows/Treatment	15	15	15
Dry Matter Intake (kg/cow/day)	18.7	19.5	18.7
Milk Yield (kg/cow/day)	33.8a*	35.1a	30.9b*
Week of Peak	5	8	5
Fat %	3.61	3.49	3.67
4% Fat-corrected Milk (kg/cow/day)	31.4ab	31.9a	29.1b

* treatments with unlike superscripts (a, b) are different ($P < .05$)



The cows in CRF-372 were fed NSC-balanced feeds blended with hay-crop silage (alfalfa).

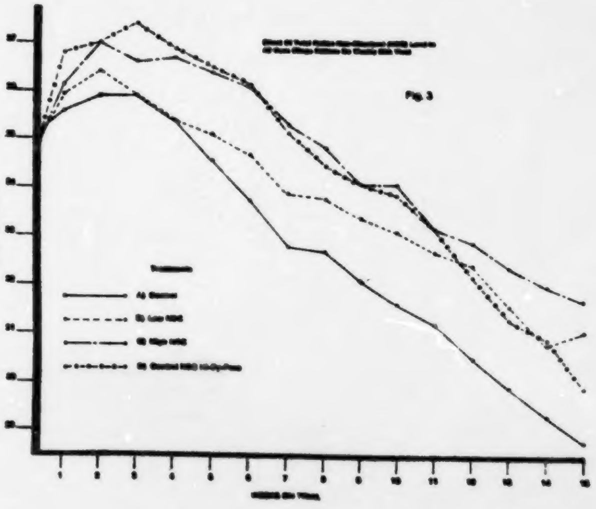
The following table and figure illustrates the results of another experiment (CRF-384). In this experiment, four rations were used: Control NSC, Control-NSC high-by-pass, Low NSC, and High (optimum) NSC. These rations were formulated to investigate (pin-point) the level of NSC that would be optimum. From CRF-372, we knew approximately what level we needed; now we were attempting to become exact. The Control NSC high-by-pass treatment was added to confirm that the controlled-solubility concept still applied, and whether the levels of insoluble proteins were adequate.

Table: Result of CRF-384: Effect of total ration non-structural carbohydrate level in all-corn silage ration on production parameters during the first fifteen weeks of lactation

Variable	Low NSC	Control NSC	Control NSC High-by-pass	High NSC
Cows/ Treatment	15	15	15	15
Dry Matter Intake (kg/cow/day)	20.4	19.2	19.6	19.3
Milk Yield (kg/cow/day)	33.7bc*	32.7c	34.4bc	34.6b*
Covariantly adj. fat percent	3.57	3.33	3.42	3.57
Milk Yield Efficiency (kg Milk/kg DM)	1.68e*	1.73de	1.79de	1.82d*

* treatments with unlike superscripts (bc, de) are different ($P < .05$)

Weekly Milk Yields (CRF-384)



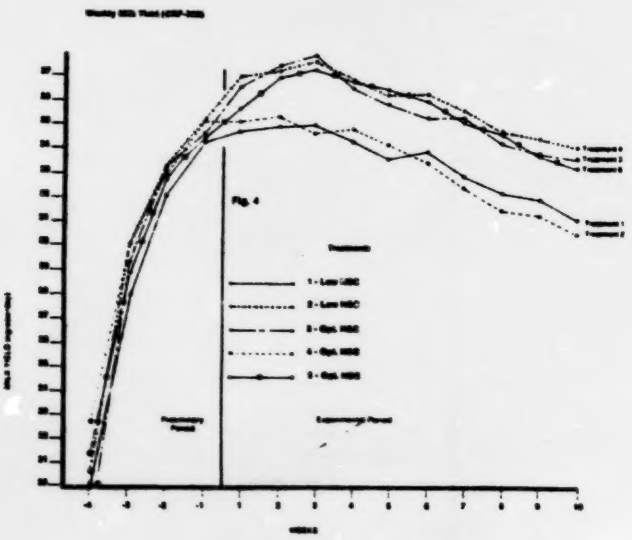
The third trial involved specific formulations with various ingredients. A particularly interesting treatment is treatment 5 where canola meal and barley were used in combination with 4 other protein sources to produce a specific NSC balanced feed.

Table: Effect of total ration NSC and ingredient levels on production parameters (CRF-386)

	Treatments				
	1	2	*3	4	5
Variables	Low NSC	Low NSC	OPT. NSC	OPT. NSC	OPT. NSC
Cows/Treatment	19	19	19	19	19
Dry Matter Intake (kg/cow/day)	19.4	19.4	20.5	20.5	19.4
Milk Yield (kg/cow/day)	33.4a**	33.3a	35.6b**	36.0b	35.6b
4% Fat-corrected Milk (kg/cow/day)	30.8	30.8	32.7	32.4	31.7
Fat %	3.47	3.52	3.46	3.33	3.30

* OPT. = optimum

** treatments with unlike superscripts (a, b) are different ($P < .05$)



Trial Summary

It is important to remember that in each trial, the levels of energy, protein, minerals, and vitamins were the same for all treatments. What we varied was the level of non-structural carbohydrates. The responses were from 0.9 to 4.2 kg more milk/cow/day. That is 2 to 9 pounds more milk. We knew that to increase the efficiency with which cows produce milk, we must first properly feed the rumen microbes to make them more efficient. By balancing the amount of non-structural carbohydrates in the total ration, we can increase the milk yield of early-lactating dairy cows and we are able to do this more efficiently (i.e. more pounds of milk from every pound of feed).

We, at CO-OP Feeds, through the efforts of the Co-operative Research Farms, are proud to bring to you the latest advance in dairy feeds - BND Dairy Feeds. BND Dairy Feeds incorporate the most current research discoveries in dairy feeding and, thus, help your cows to produce milk more efficiently.

BUILDING BETTER FENCES USING HIGH TENSILE SMOOTH WIRE

Brain English, Agricultural Engineer, Manitoba Agriculture

PART I INTRODUCTION

"Good fences make good neighbours."[1]. Fences provide protection for crops, control over breeding, protection of livestock, and are a good pasture management tool.

Fence design and development have not changed since barbed wire was patented in 1874 in the United States. A new type of fencing called "high-tensile smooth wire fencing" is presently gaining popularity. High-tensile smooth wire fencing has been in use in New Zealand and Australia for more than two decades and is presently being used in North America.

This fencing system makes use of multiple strands of smooth, 12.5 gauge, high-tensile galvanized steel wire. Each strand, when strung and stretched to the recommended 1.10 - 1.30 kN (250 -300 lb) of tension, withstands up to 6.70 kN (1500 lb) of livestock pressure and low temperature contraction without breaking.

High-tensile wire fences are versatile; they can be used in practically any fencing situation. By modifying the number and the space between strands, the fence can be used to contain horses, sheep, cattle and hogs. Special designs are used to provide protection from predators and wildlife.

Ideally a fence should have a low capital cost, be easy to install, have a long lifespan and be stockproof. High-tensile smooth wire fencing is such a system. The advantages of this type of fencing over conventional barbed wire fencing are:

1. **Cost:** High-tensile smooth wire is about half the cost of barbed wire per unit of length.
2. **Elasticity:** There are no barbs to catch on posts or staples, so the wire behaves elastically along its complete length. Impact at one point is redistributed to the brace assemblies at either end.
3. **Ease Of Handling:** The absence of barbs makes the wire easier to handle and effectively reduces construction costs.
4. **Safety:** Smooth wire has no barbs, reducing injury to livestock, particularly horses.
5. **Stretching:** High-tensile wire is prestretched and requires no additional stretching.

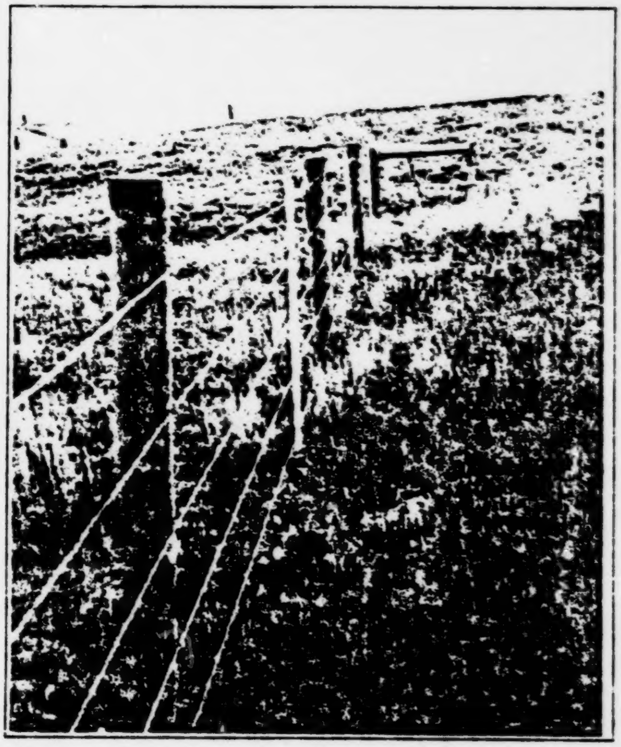


Figure 1. Typical range application of high-tensile smooth wire fencing.

6. **Repairs and Maintenance:** The wire's high elasticity and high breaking loads make it a more durable fence requiring less repair and maintenance, particularly in areas of heavy snow load or stock pressure. High-tensile smooth wire should have Type III galvanizing, which means a longer wire life. (Type III galvanizing is a thicker coat of galvanizing material than is found on standard wire.)

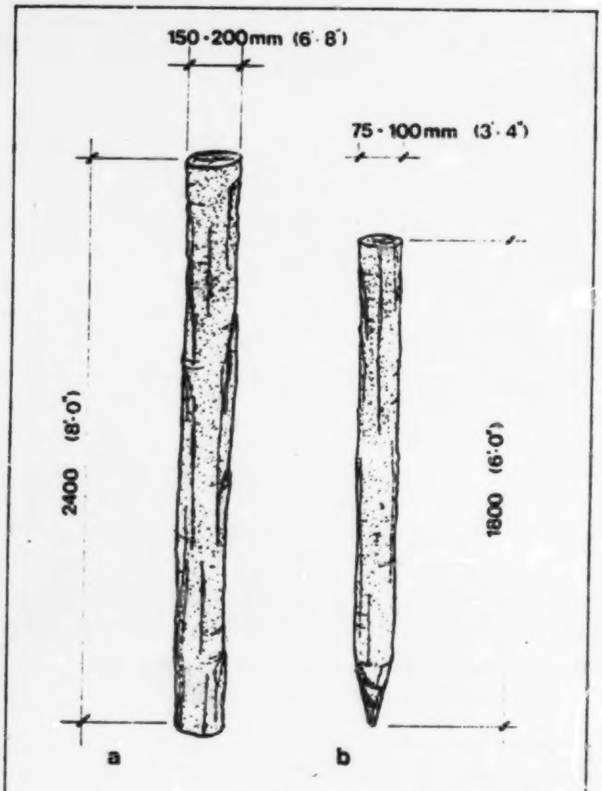
However, special tools, materials and techniques are needed to properly construct high-tensile smooth wire fences.

*Information from Alberta Agriculture's High Tensile Fencing Manual

PART II MATERIALS

Posts

Wood is a suitable material for fence posts and braces. The life expectancy of high-tensile smooth wire fencing constructed with pressure treated posts and braces is over 30 years. Round wood posts are used so there are no sharp corners to kink wires or to injure livestock. Posts 150-200 mm (6-8 in.) in diameter are used to provide strength at ends, corners, braces and gates.



a) 150 - 200 mm post for end brace assemblies
b) picket used to support and space wires

Figure 2. Pressure treated fence posts

Wire

Wire used for high-tensile smooth wire fences is commonly 12.5 gauge high-tensile smooth wire, though other gauges are available from several manufacturers.

Fasteners and Hardware

Staples: Use 50 mm (2.0 in.) long staples, with slash cut points. The staples are not driven all the way home in the posts, so that the wire can slide through them.

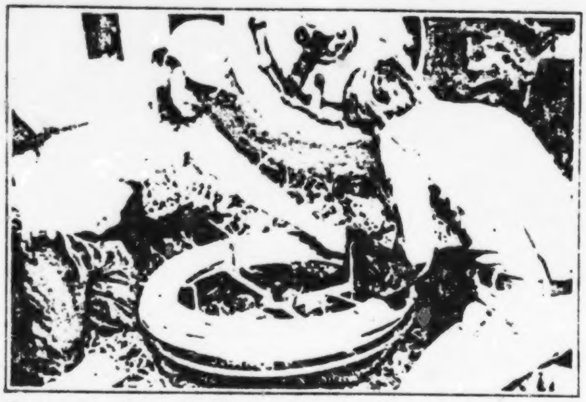


Figure 3. Coil of high-tensile smooth wire on a spinning jenny.

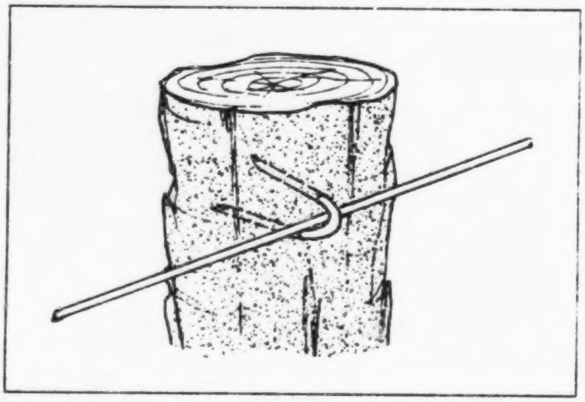


Figure 4. Staple. Note the space so that the wire can slide through the staple.

Metal dowels: Dowels should be used for constructing end, corner, gate and in line brace assemblies. Either 10M rebar or 10 mm steel rods, cut to length, can be used. For maximum dowel life, dowels should be galvanized. One 225 mm (9 in.) long and one 100 mm (4 in.) long will be needed for each single-span brace. Braces using dowels will be stronger than braces constructed using spikes.

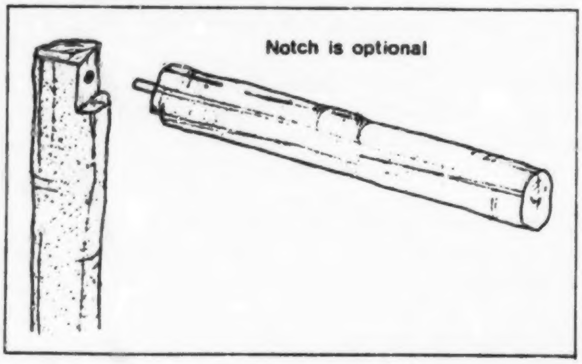


Figure 5. Dowels used to attach brace to post.

Tying off at end posts: Individual high-tensile wires can be fastened to all braces by tying off the wire with an end-post knot. This knot has only 60% of the strength of the wire.

or

Crimping sleeves can be used in tying off the wire at the end posts. Four sleeves are as strong as the wire, and are the recommended method for tying off wires.

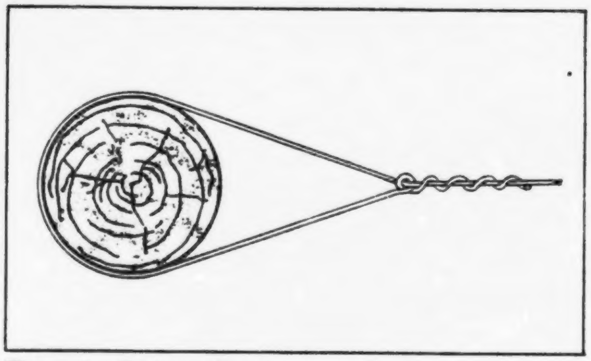


Figure 6. End post knot.

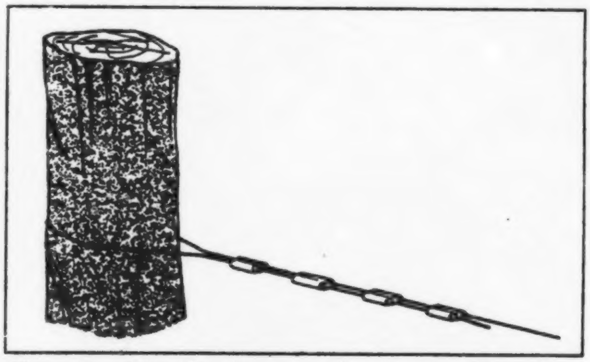


Figure 7. Crimping sleeves used to tie wire off at the end post.

In-line wire splices: A figure-eight knot can be used to tie two ends of high-tensile wire. These knots have only 75% of the strength of the wire. Crimping sleeves can be used as in-line wire splicers, 4 sleeves are required for each splice. Crimping sleeve splices are as strong as the wire, and are the recommended splicing method.

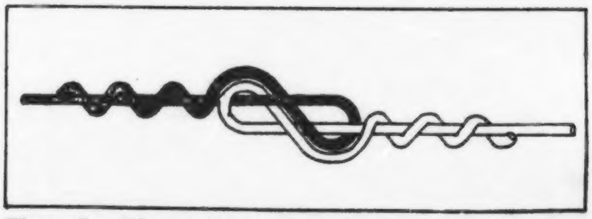


Figure 8. Figure eight-knot for in-line splice.

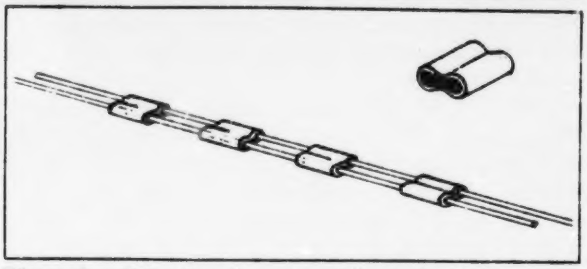


Figure 9. Crimping sleeves used for in-line splice.

In-line tension adjuster: One in-line tension adjusting device is required for each length of wire. One readily available model requires cutting the wire and uses a removable handle to wind the wire onto an automatic locking, non-slip spool. Another model is also available which does not require cutting the wire. The cost of an in-line tension adjuster is nominal.

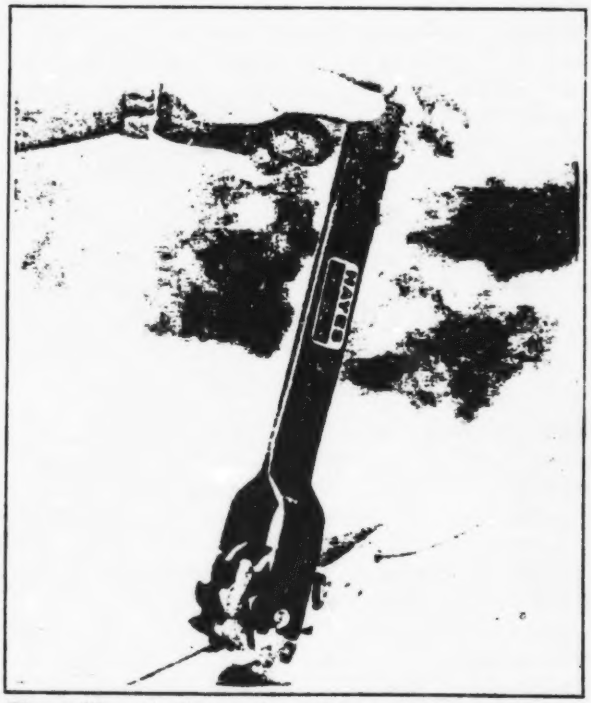


Figure 10a. In-line tension adjuster which requires cutting the wire

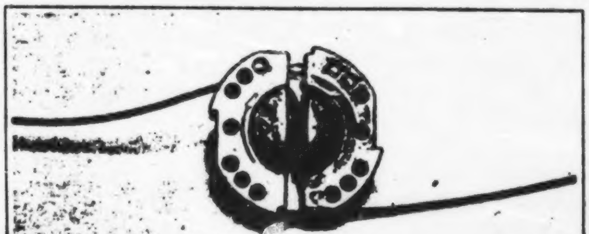


Figure 10b. In-line tension adjuster which does not require cutting the wire.

Grounding the fence: Each year lightning causes the loss of livestock. Wire fences should be grounded and their electrical conductivity broken by separating each section. Fences should be grounded every 50 m (165 ft) in dry soils and 100 m (330 ft) in damp ground. Grounding is done by driving a 12 mm (0.5 in.) galvanized steel rod or pipe 2 m (6.6 ft) into clay or clay loam, and at least 3 m (10 ft) in sand or gravel. Fence wires are then grounded to the ground rod. In addition to grounding the fence, its electrical conductivity should be broken every 500 m (1650 ft). This is done by tying the wire off at the posts.

If the fence has to be built in the close proximity of high voltage power lines special precautions need to be taken. Contact the transmission department of the utility company for special grounding instructions.

- **Droppers (stays):** One of the principal functions of a post is to maintain wire separation or spacing. This may be done at a lower cost by installing droppers which are not driven into the ground. When using droppers, spaced at 3 m (10 ft), line post spacing can be extended up to 20 m (66 ft), depending on the terrain and the kind of livestock. This significantly reduces material costs.

Conventional dropper designs tend to slide on smooth wire. Special dropper designs are used to prevent sliding. The wire is crimped as it crosses the dropper surface; this prevents the dropper sliding. Droppers can be made of wood or metal.

Wood droppers: Treated 2 x 2's with angle-cut grooves for wires are commonly used. Hardwood is preferred over softer woods. It is best to cut alternate grooves on opposing sides of the dropper so it can not slide on the wire. Alternatively, wood droppers can be stapled to the wire, though dropper sliding may be experienced.

Metal droppers: Two types of metal droppers have been developed. One is U-shaped with notches cut so the wire angles across the dropper, and the dropper will not slide on the wire. This design of dropper has the disadvantage of wearing the galvanizing off the wire. The second type uses a U shaped section with rolled edges. Instead of using notches, the wire is held in place by a pin inserted through holes and bent around the wire.

Dropper availability could be a problem. If they are not readily available, use posts at a 5 to 6 m (15 - 20 ft) spacing.

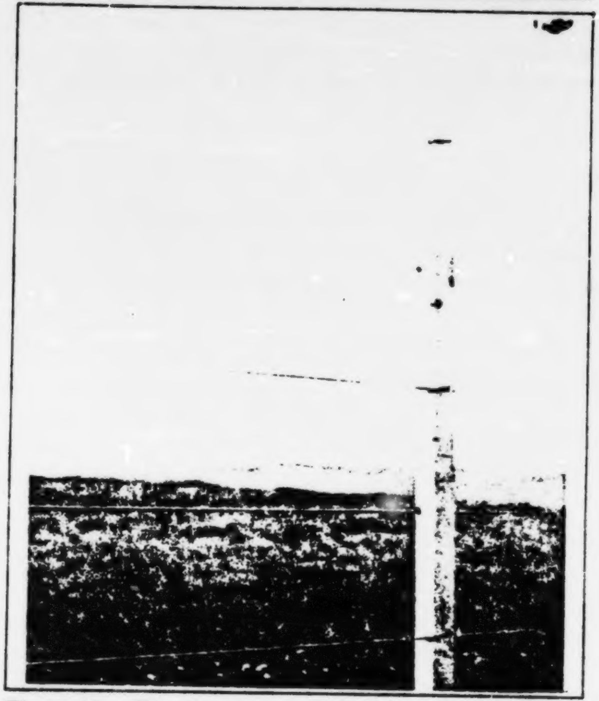


Figure 11. Wood dropper on high-tensile smooth wire fence.

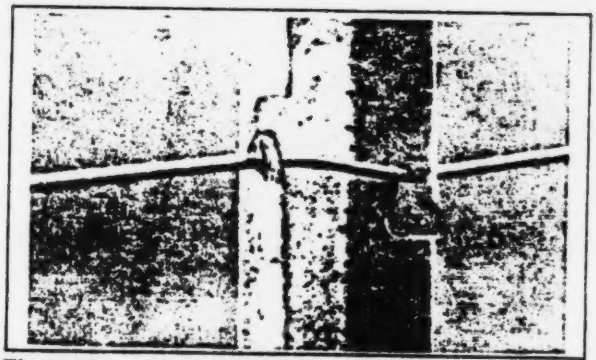


Figure 12a. Notched metal dropper.

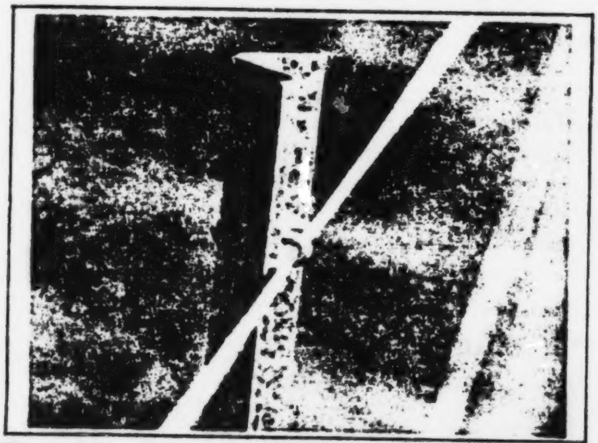


Figure 12b. Pinned metal dropper.

■ Tools

Like any other fencing, high-tensile wire fencing requires an assortment of tools such as hammer, fencing pliers, post driver, saw, brace and bit, etc. A crimping tool is used for in-line wire splices or fastening to endposts. A tension tester is used to measure the tension in each wire.

A "spinning jenny" is also useful for unrolling wire without entanglement. Uniform play out is important to prevent kinks which weaken the wire.

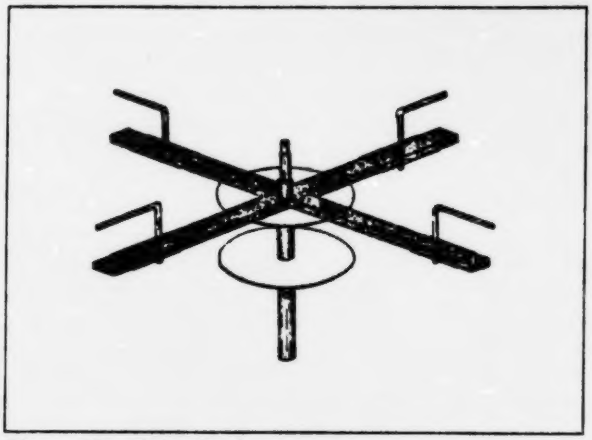


Figure 13. Spinning Jenny.

Note: High-tensile wire is stiff and has a tendency to recoil when it is cut. When cutting high-tensile wire, hold the needed end in one hand and the unneeded end down with one foot. If it is necessary to let go of the cut end, weight it down with a tool, or simply push the end several centimetres (inches) into the soil.

PART III CONSTRUCTION

The lifespan of a high-tensile smooth wire fence is expected to be 30 years or longer. To ensure that the fence lasts this long it must be constructed of quality materials with top workmanship. Also, the location of the fence should be chosen so that it will fit your long term management plan. It is uneconomical to move a fence with a 30-year life after only 5 to 10 years of use.

- **Laying Out the Fenceline**

Once the general location of the fence has been decided, walk or ride it. Pick your fence location (if possible) to avoid hazards such as steep sidehills or sloughs, and avoid corners as much as possible. By minimizing these hazards a strong fence that is easy to maintain can be constructed.

- **Posts and Guide Wire**

The first step in fence construction is to place end, corner and gate posts. These posts serve as anchor points for stringing guide wires, and also act as part of the brace assemblies. The posts should be 150 - 200 mm x 2400 mm (6 - 8 in. x 8 ft) and set 1.25 m (50 in.) deep. Line posts are 75 - 100 mm x 1800 mm (3 - 4 in. x 6 ft) and driven 600 to 700 mm (24 in. to 26 in.) into the ground.

To set end, corner and gate posts, a smaller diameter pilot hole is augered to 900 mm (3 ft). The holes serves as a guide for pounding the post. It is augered at a slight incline so that when the post is set it will lean opposite to the pull of the wires. (top of post is about 5 mm (2 in.) off the vertical).

After all end, corner and gate posts are in place, two guide wires are strung. One is the top wire of the fence, the other the bottom wire. These wires are used to accurately place line posts on the fenceline and to maintain vertical alignment of the posts.

Once the wires have been fastened to the posts (by knots or crimping sleeves) place in-line tensioners and adjust the tension in the wires to about 0.44 kN (100 lb). Now check to see that the wires are straight. On uneven terrain, drive line posts on hilltops and at the bottom of dips to keep the wires straight and true.

- **End Brace Assembly**

Two types of brace assembly are used: single and double span. A span length of 2400 mm (8 ft) is used for each span in a double brace but a minimum span of 3000 mm (10 ft) is preferred for a single brace. Under most fencing conditions a single span brace is preferred. Research at Kamloops has shown single braces to be as strong as most double braces. Braces are spaced as far apart as the terrain will allow, to a maximum of 500 m (1650 ft).

A double brace assembly should be used under poor soil conditions or if more than 6 wires are used. The two boxes making up the double brace must be perfectly in line with each other, as well as being in-line with the fence. If they are not lined up, the strength is less than that of a single brace.

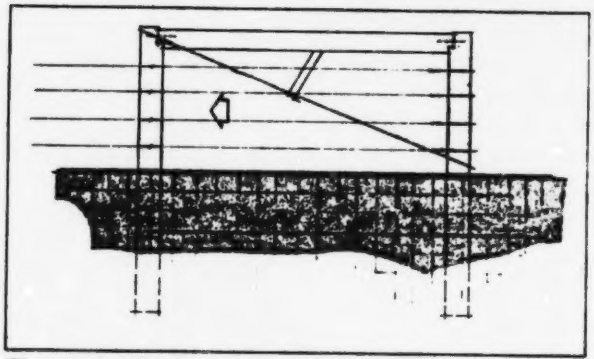


Figure 14. Single span brace assembly.

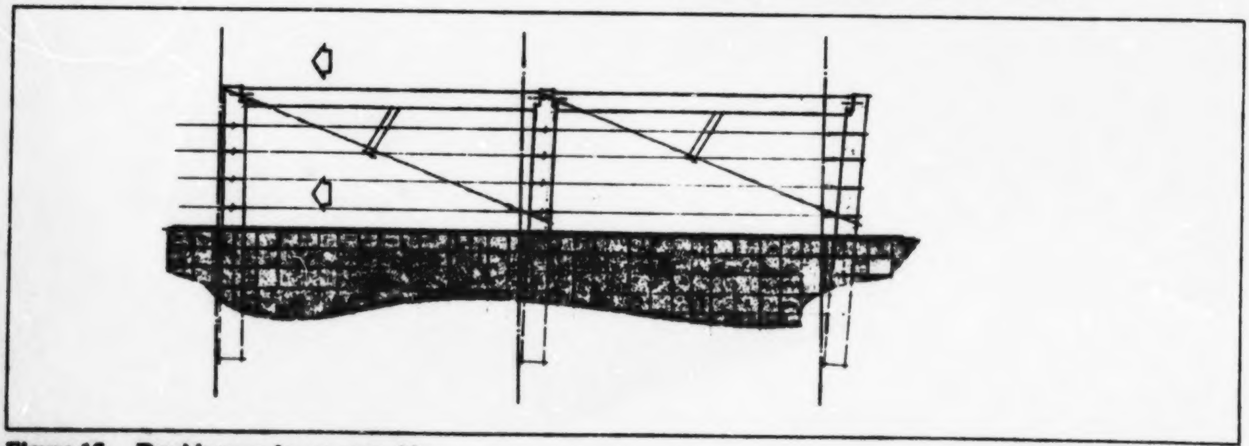


Figure 15. Double span brace assembly.

The horizontal brace for both a single and double span-type is pegged into place using 10 mm (⅜ in.) rods. The rods are driven through a hole in the side of the post 75 - 100 mm (3 - 4 in.) from the top and into a hole drilled in the end of the horizontal brace. The holes should be slightly smaller in diameter than the rod. Shallow notching of the post to accept the horizontal brace can also be used. Leave 25 to 50 mm (1 to 2 in.) of the pin exposed to hold the brace wires in place.

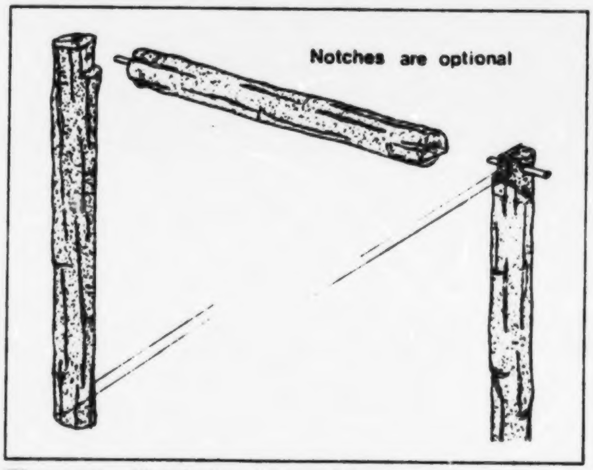


Figure 16. Notched and pinned brace.

Once the posts and horizontal brace are in position, the brace wire can be attached. Drive a staple half way into the post, 100 mm (4 in.) from the ground at the back of the end post. Two wraps of wire are placed under the staple on the end post and over the pin stub on the other brace post and tied off. A pressure-treated twitch stake is used to adjust tension in the wires. It is locked behind the horizontal brace so that it will not unwind. Or the tension can be adjusted in the brace wires with a temporary smooth wire tension adjuster, then crimped. Figure 17 demonstrates the construction of an end brace.

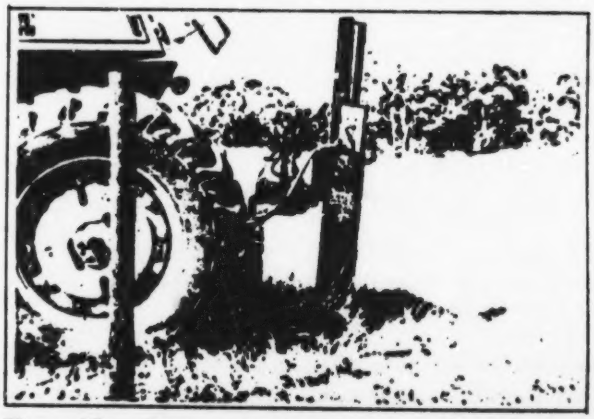


Figure 17a. Brace posts after driving.

Figure 17b. Drilling the holes for the pin.

Figure 17c. Wrapping the base wire.

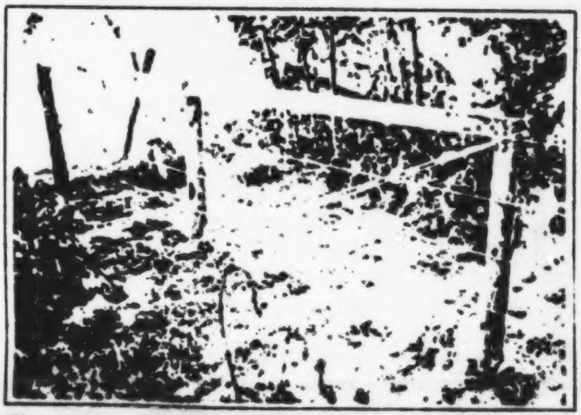


Figure 17d. Finished brace assembly.

- **In-Line Brace**

A single span end brace assembly should be used for all in-line braces. A second brace wire forms an X with the first wire. Fence wires must continue to the far side of the brace assembly so that the forces are distributed across the brace.

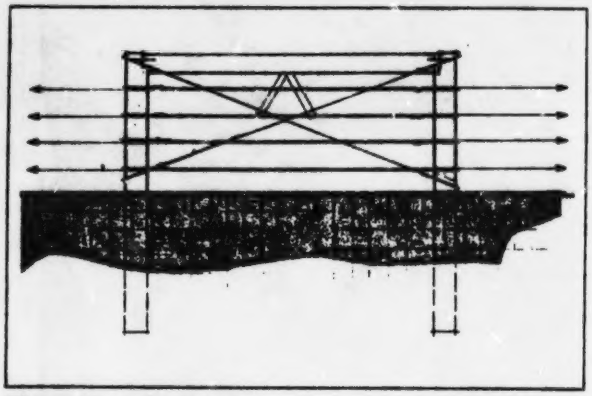


Figure 18. Construction of in-line brace assembly.

- **Corner Assemblies**

Keep the number of angles in the fence to a minimum. Figure 19a shows a good corner brace. However, it is possible to fence around gentle curves without constructing corner brace assemblies, as shown in Figure 19b.

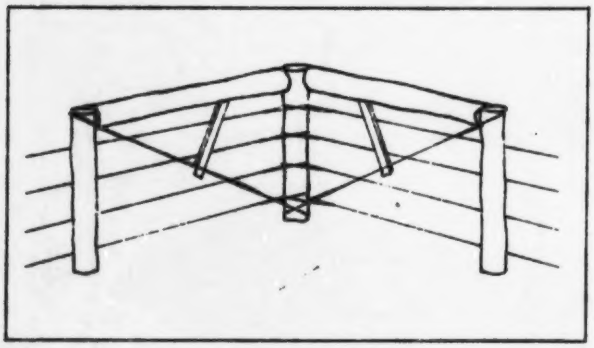


Figure 19a. Corner brace assembly.

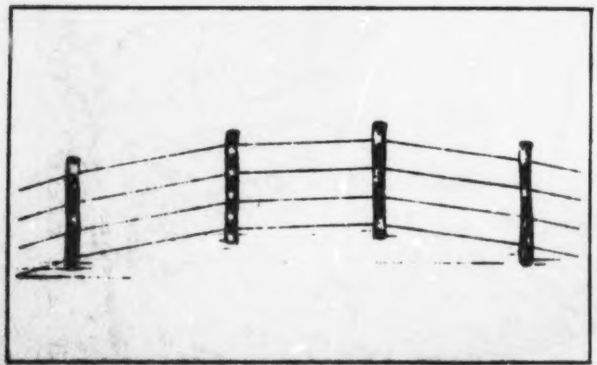


Figure 19b. Fencing a gentle curve without using corner brace assembly

- **Bracing On A Changing Slope**

A double in-line brace assembly should be constructed where there is a major change in slope. The centre post of the assembly is located at the break in the slope. Each half of the assembly is then constructed on its respective slope. Wires from both directions are tied off at the centre post of the brace assembly.

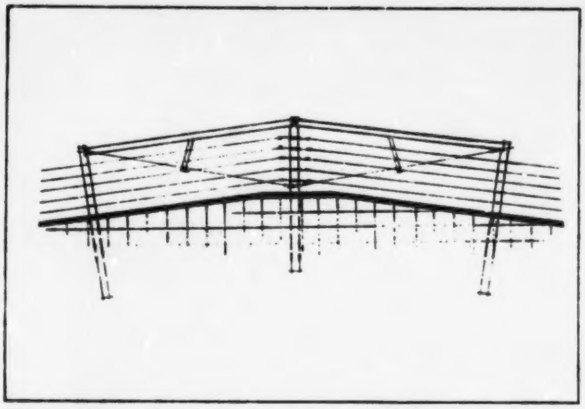


Figure 20a. Bracing at the top of a rise.

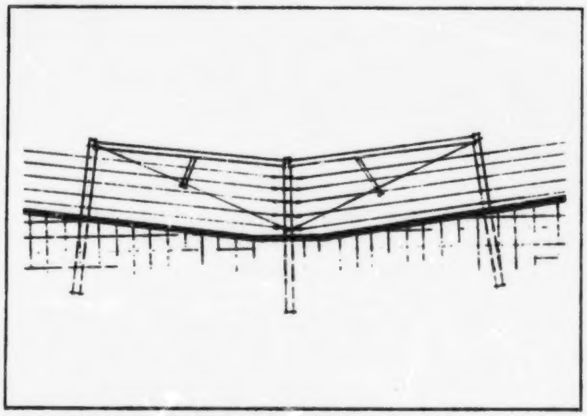


Figure 20b. Bracing at the bottom of a dip.

- **Driving the Line Posts**

The two guide wires are used to set the posts straight and vertical.

When fencing up and down slopes, posts should be driven perpendicular to the surface of the ground. Not following this procedure will reduce the height of the fence. Note, in Figure 21b that post placement is perpendicular to the ground surface.

Wire should be located between the posts and the greatest livestock pressure. On sloping terrain, the wire is on the uphill side of the post.

Line posts are usually spaced 5 to 6 m (15 to 20 ft). By using one or more droppers, post spacing may be up to 20 m (66 ft).

Fencing Through Dips or Gullies

For small dips or gullies take the main fence straight across; posts are driven in the dip. Extra wire is used to form a V between the main line posts and the posts in the dip.

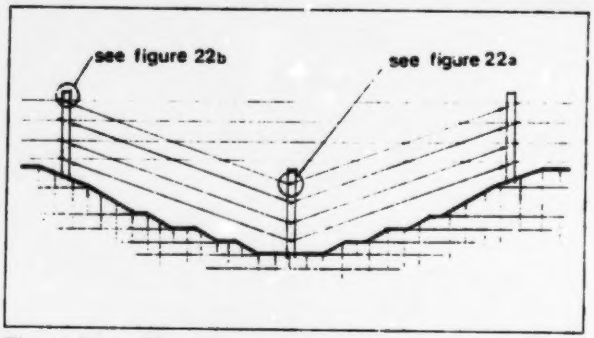


Figure 21a. Fencing across a small gully.

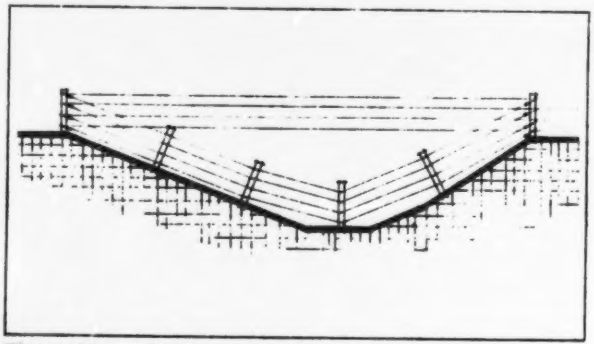


Figure 21b. Fencing through a larger gully.

Wire Spacing

The number of wires and the spacing between the wires will depend on the kind of livestock. Normally you can replace standard barbed wire strand for strand—areas now using 4-strand barbed wire can use 4-strand high-tensile smooth wire.

Table 1 gives application and wire spacings for high-tensile smooth wire fences.

Stapling

Before stapling, adjust tension in each wire to 0.44 kN (100 lb) tension. This is to prevent the wires crossing and being stapled at wrong levels on the posts.

Staples should never be driven all the way "home" into the post. Doing so results in a less effective fence; the resistance from the staples does not allow the wire to behave elastically along its full length. It can also kink the wire, making it weaker.

Use 50 mm (2 in.) or longer staples because 45 mm (1 ¾ in.) staples are too short to allow proper wire clearance. Always rotate the staple so that the slash cut forces the legs to spread in the post, increasing holding power.

To counteract the pull of the wire in dips and on hills, drive staples at an upward angle into dip posts and at a downward angle into hill posts. On very steep rises or dips, driving two staples in either of the ways shown in Figure 22 helps to hold the wires against the posts and is a good insurance against pullout.

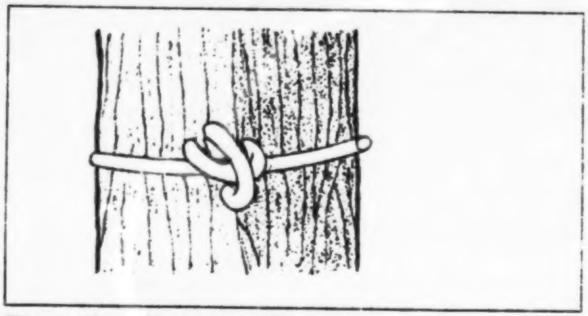


Figure 22a. Staple installation on a dip post.

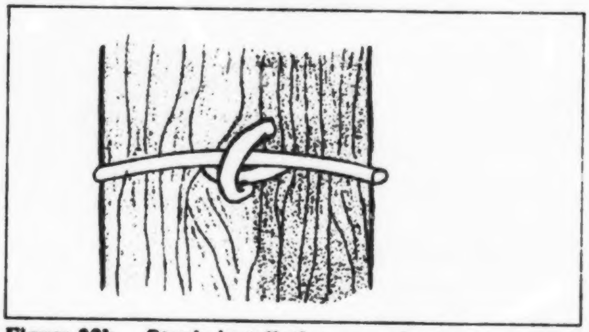


Figure 22b. Staple installation on a rise post.

Friction between the wire and the posts on gentle curves can be reduced by placing staples between the wire and the posts. This can be accomplished by stapling as shown in Figure 23.

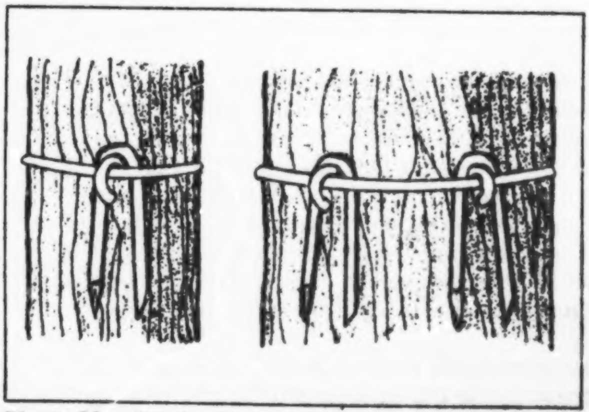


Figure 23. Staple placement to support wire around end or corner posts.

TABLE 1. HIGH-TENSILE SMOOTH WIRE FENCE APPLICATIONS AND WIRE SPACINGS

NUMBER OF STRANDS	APPLICATION	HEIGHT FROM GROUND mm (inches)	WIRE SPACING (from ground up) mm (inches)
4	Replaces 3 and 4	1010 (40)	380 (15), 200 (8), 200 (8), 230 (9)
4	(pasture and range fencing	1160 (46)	380 (15), 250 (10), 250 (10), 280 (11)
5	Designed for moderate to heavy grazing by large animals (horses, etc.)	1140 (45)	400 (16), 180 (7), 180 (7), 180 (7), 200 (8)
6	and for longer post spacing [12 m or more (40 feet or more)]	1160 (46)	330 (13), 150 (6), 150 (6), 150 (6), 180 (7), 200 (8)
8	Contains small and large animals discourages some wildlife and dogs, and longer post spacings	1170 (46)	100 (4), 130 (5), 130 (5), 130 (5), 150 (6), 150 (6), 180 (7), 200 (8)
*10	Replaces woven wire, will contain most kinds of livestock, turns away dogs and wildlife; discourages predators if 2nd, 4th and top wires are electrified	1180 (46)	100 (4), 100 (4), 100 (4), 100 (4), 130 (5), 130 (5), 130 (5), 130 (5), 130 (5), 130 (5)
10	feedlot fence	1330 (52)	250 (10), 100 (4), 100 (4), 100 (4), 130 (5), 130 (5), 130 (5), 130 (5), 130 (5), 130 (5)
12	horse fencing	1460 (57)	100 (4), 100 (4), 100 (4), 100 (4), 130 (5), 130 (5), 130 (5), 130 (5), 130 (5), 130 (5), 130 (5), 150 (6)

**Note:* posts are drilled for this wire, or staggered on alternate sides of this wire.

- **Placing the In-Line Tension Adjuster**

In-line tension adjusters should be installed at the mid-point between braces. This makes it easier to adjust the tension in the fence. However, the tensioner should not be installed immediately next to changes in slope, nor between any two posts within a corner or a curve. On fences less than 200 m (660 ft) long tensioners can be installed at either end of the fence, or near a gate for easy accessibility.

As a general guide use one in-line wire tension adjuster per strand for every 500 m (1650 ft). If the terrain is very rough this distance will be reduced. Fences which contain several corners or curves or rises and dips may require two or more tension adjusters per wire.

Wire tension should be adjusted in stages of 0.44 kN (100 lb) to a maximum tension of 1.10 - 1.3 kN (250 - 300 lb). Work from the top wire downwards for easier separation of the wires and to provide clearance for turning the handle. The in-line tension adjuster also permits seasonal adjustment of wire tension to compensate for temperature change. During the winter, tension on the wires should be reduced or a spring assembly should be used. A spring assembly is shown in Figure 24.

TABLE 2. WIRE TENSIONS FOR SEVERAL TEMPERATURES

Temperatures	Tension
-10°C	1.55 kN (350 lb)
0°C	1.33 kN (300 lb)
10°C	1.22 kN (275 lb)
20°C	1.11 kN (250 lb)

It is possible to measure the approximate tension on any particular stand anywhere on the fenceline by means of a simple device which you can make at low cost. Figure 25 shows a homemade wire tension tester. Take a piece of wood 1100 mm (42 in.) long and place nails 1016 mm (40 in.) apart. Use a spring scale that will measure up to 10 kg (22 lb), and pull the wire with the spring scale to deflect the wire 12.7 mm (0.5 in.). Read the scale and multiply the scale reading to obtain the tension. If reading in pounds, multiply by 20 for pounds of wire tension, or by 0.09 to get kN of wire tension. If the reading is in kg, multiply by 0.20 to get kN of wire tension.

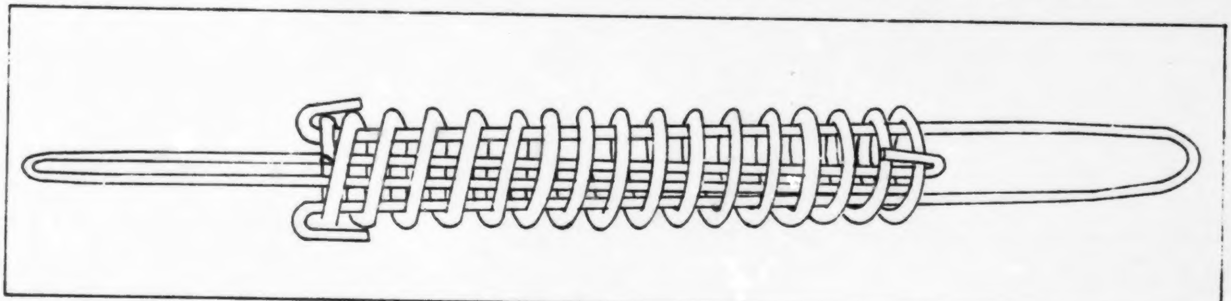


Figure 24. Tension spring assembly

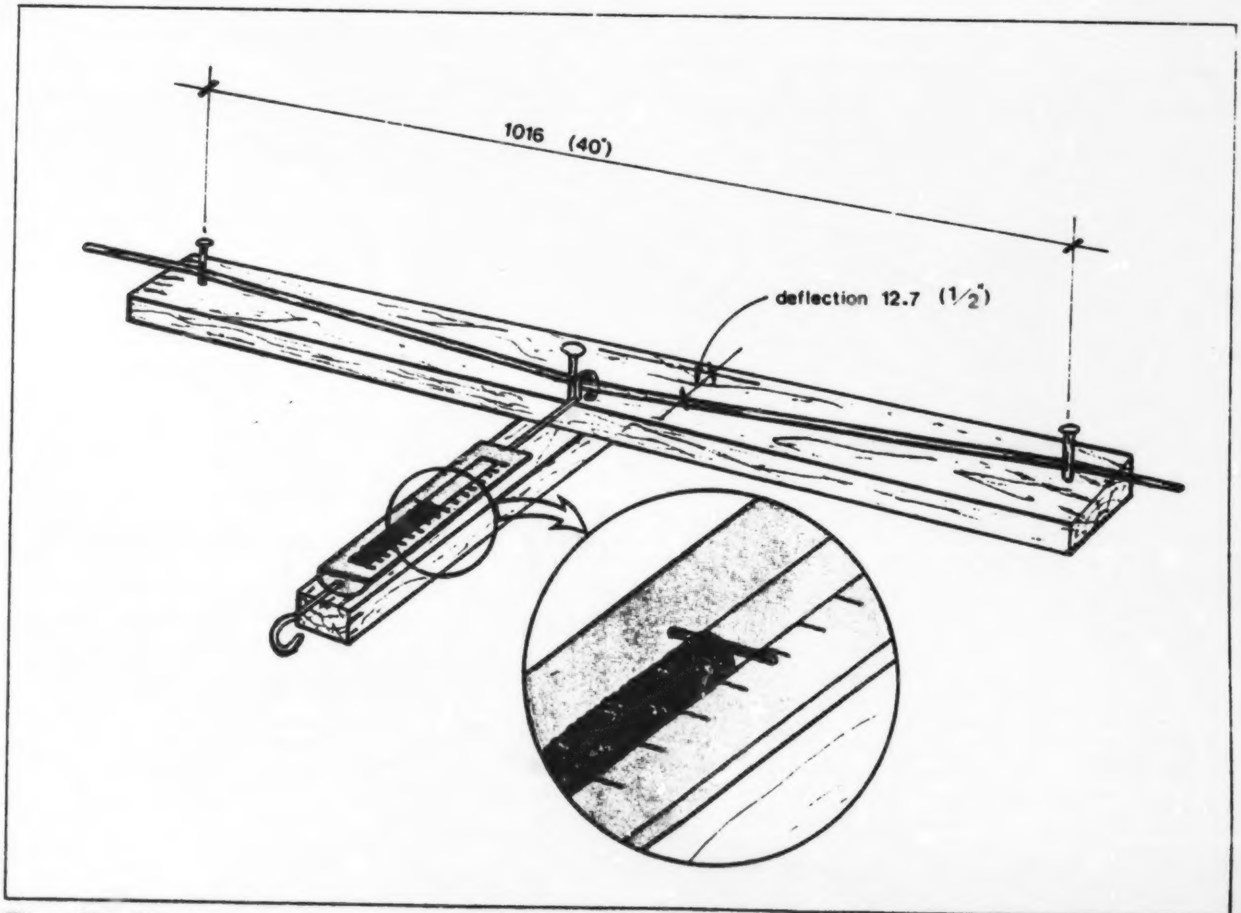


Figure 25. Wire tension meter.

Gate Types and Location

When locating and installing livestock and machinery gates in high-tensile smooth wire fences, use the same considerations that apply to gates in other types of fences. Such gates should be (1) located for maximum convenience and efficiency in farm management, (2) at least as high as the fence, (3) wide enough to permit passage of the widest piece of machinery, (4) level enough and hinged on the proper side to swing freely, and (5) durable enough to last as long as the fence.

There are a variety of styles and sizes of prefabricated gates available and they are usually excellent for use in high-tensile smooth wire fences. Gates can also be fabricated on site at a lower cost with pressure-treated lumber or steel pipe with wires as shown in Figure 27. For gates that you frequently drive through, a "Texas gate" (cattle guard) can also be installed. Basically a "Texas gate" (cattle guard) is made by spacing a pipe grate over a dip in such manner that the livestock can not walk over it but cars and farm machinery can. CPS Plan M8362 shows the details of a "Texas gate", and is available from Alberta Agriculture.

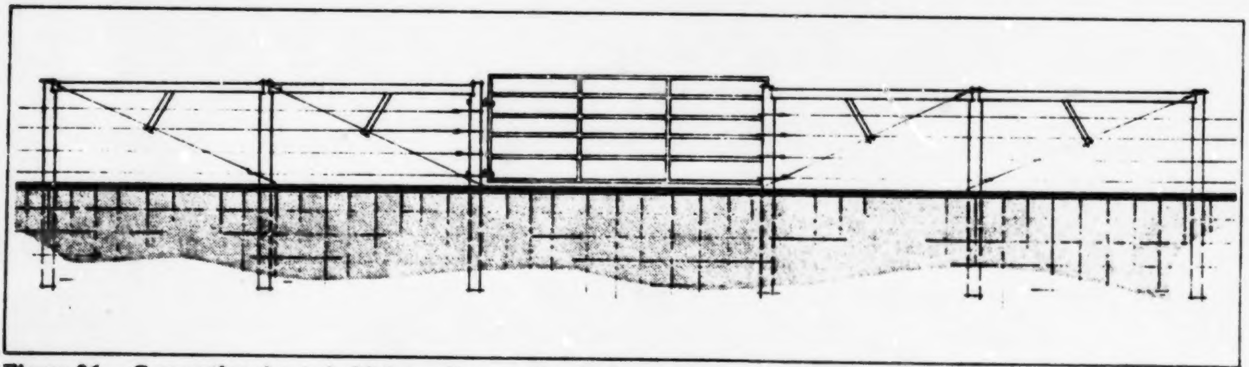
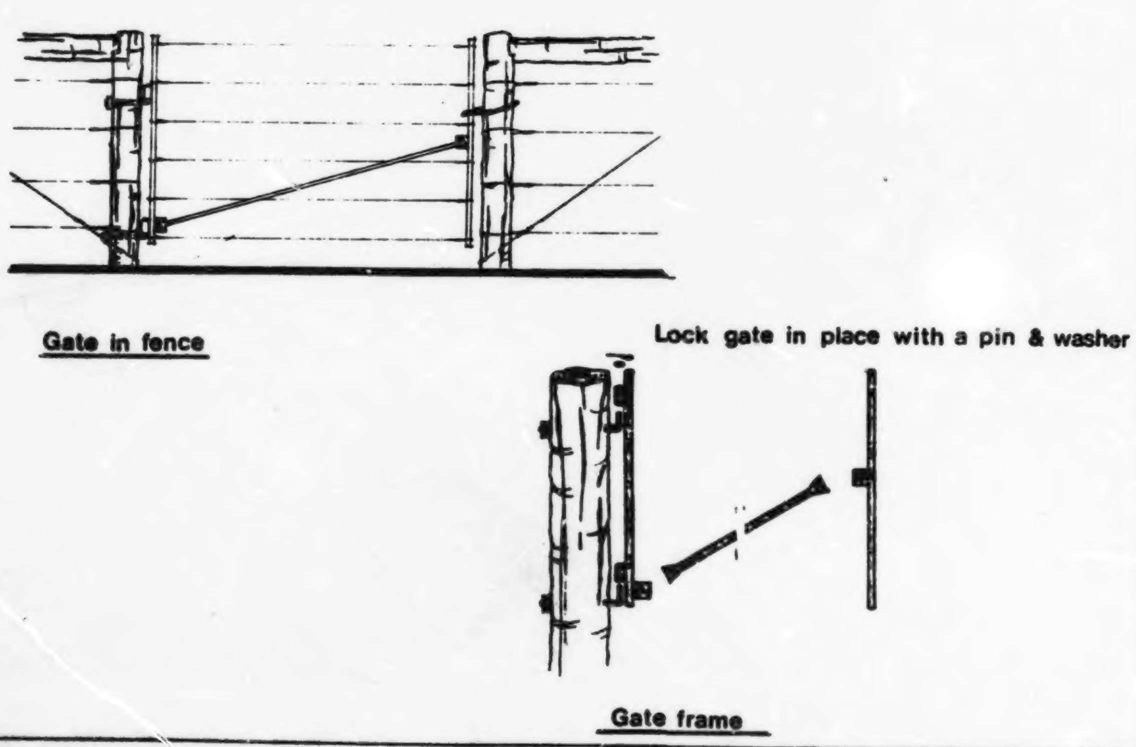


Figure 26. Conventional gate in high-tensile smooth wire fence.



igure 27. Light weight gate in high-tensile smooth wire fence.

In boundary fences near busy roadways, it may be necessary to set gates back from the fenceline to permit pulling long farm implements off the roadway. In such instances, it is more practical to build a plank fence on the sides of the offset than to erect two short sections of high-tensile wire fence.

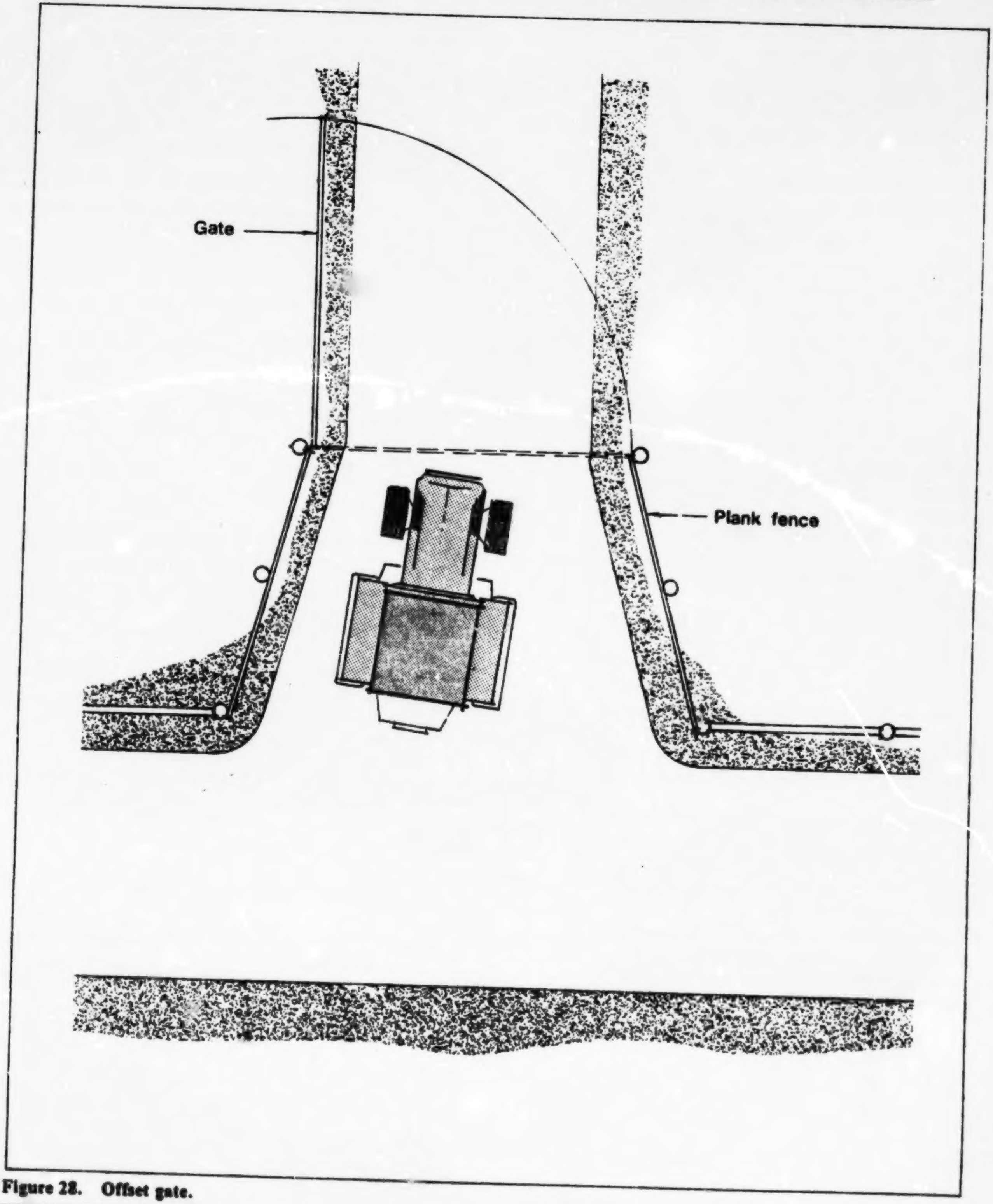


Figure 28. Offset gate.

PART IV SAFE FENCING PRACTICES

Anyone building a wire fence is subject to cuts and scratches from the wire. Chance of injury will be reduced by observing the following safety precautions:

- Wear tightly woven, tough clothing that will not catch on the ends of the wire.
- Wear heavy-duty, gauntlet-type leather gloves which fit snugly.
- Wear long pants and high work shoes with heavy soles to protect the feet and legs.
- Have the right tool for each job, keep it in good condition and use it only according to manufacturer's directions.
- Wear safety goggles or eye shields when cutting the wire or adjusting the tension of the wire, as well as when driving nails or staples.
- Never carry nails or staples in pants pockets. Use a nail apron or tool bag.
- Use driving caps on posts as recommended by the post driver manufacturer.
- Keep children and livestock away from all fencing operations.
- When handling, driving, drilling, nailing or stapling chemically treated wood posts or lumber, wear face shields and rubber gloves, and cover otherwise unprotected areas of your skin. Some people are allergic to wood-preserving chemicals.
- Never use unsafe shortcuts, or eliminate such items as safety wires on twitch sticks.
- Pick up all cut ends of wire, dropped staples and nails, etc., so they will not cause injury to humans, be eaten by grazing livestock,damage mower blades, or snarl equipment.
- Don't work at fencing during electrical storms.
- Properly ground the fence as soon as it is erected.
- Remember, wire is an excellent conductor. Be careful when stringing the guide wire or line wires that they do not come in contact with any powerlines overhead or at ground level where you are working.
- Be cautious when driving posts in the vicinity of buried gaslines, electrical lines or other utilities (most utilities will locate and mark buried services).

PART V SUMMARY

High-tensile smooth wire fencing has proven to be a less expensive alternative to traditional fencing methods. Quality materials and good workmanship produce a strong, long-lasting fence. The absence of barbs produces a fence that does not damage livestock hides or injure humans.

APPENDIX I: Construction Procedure

STEP 1: Walk or ride potential fence route. Choose fence location to avoid or minimize steep sidehills, sloughs and corners.

STEP 2: Clear fenceline, levelling as many dips and hills as possible.

STEP 3: Place end posts for all brace assemblies on fenceline.

STEP 4: String top and bottom wires to act as guide wires.

STEP 5: Insert in-line wire tension devices and adjust wires until taut.

STEP 6: Using guide wires to ensure straightness, construct all brace assemblies.

STEP 7: Adjust the tension of the guide wire to 0.44 kN (100 lb).

STEP 8: Use guide wires to drive line posts to ensure they are vertical and in line.

STEP 9: Staple wire to line posts and braces.

STEP 10: Working from the top wire down, adjust wire tension to 1.11 kN (250 lb) in stages.

STEP 11: Ground fence.

STEP 12: Insert droppers as required.

STEP 13: After a few days return and adjust tension on wires.

Possible Effects of the Animal Welfare Movement on Animal Production

Presented at 1985 Animal Industry Conference
December 10, 1985

by W.D. Morrison
Department of Animal and Poultry Science
University of Guelph

Over the last several decades man's dependence on animals in the developed world has steadily decreased. Animals are no longer needed for power, either for transportation or to do work, chemistry has replaced some of the products which formerly only were available as by-products from animals, and chemical fertilizer has replaced manure in crop production. Further processing of various products including soybean protein has made inroads into a domain which was formerly completely controlled by meat.

When one couples these aspects with an increasing concern for the humane treatment of animals, it is easy to see why the questioning of intensive animal agriculture has arisen.

The early impetus to animal welfare probably arose with a book written by Ruth Harrison in 1964 entitled "Animal Machines". Without attempting to trace the development of the animal welfare movement in detail, it should perhaps be pointed out that this was followed by the Brambell Commission in the United Kingdom and the publishing of several books including "Animal Liberation" by Peter Singer in 1977, and "Animal Factories" by Mason and Singer in 1980.

In many cases these books are well written and well documented, and have caused concern at several levels of society.

For the most part, animal agriculture has been relatively silent with regard to such books and their content. The Council for Agricultural Science and Technology (CAST) published Report #91 in November of 1981 entitled "Scientific Aspects of the Welfare of Food Animals". In this publication it outlined the scientific basis for the production of various of our food producing animals. In addition, several researchers have made important contributions through research and the resulting scientific articles. Certainly, however, the attention of the media and thus of society has been focussed much more on welfare activists than on researchers ,or animal producers.

What is to be the approach of the animal industry to the welfare movement? It seems there are three primary responses that could be made. (1) Disregard the entire question. (2) Confront and fight all welfare activity. (3) Promote and maintain open and fair discussion. I believe that 1 and 2 are unacceptable and therefore will go directly to number 3.

This is not the place to go into detail with regard to the concerns of people involved in the welfare movement. It should be pointed out, however, that in many cases there is a basic philosophical difference of opinion between some animal welfare activists and those who believe that animals may be used for the well-being of man. Such activists may consider the use of animals as a form of speciesism and therefore unacceptable. Others hold the view that while it is permissable to use animals for the well-being of humans, such use must not constitute exploitation, and must not place animals in unnatural situations. Thus, those holding such a view might believe it acceptable to keep chickens for egg production, but not acceptable to keep them in cages or confined in any way.

A serious problem in this entire picture is how one assesses welfare in an animal. Animal producers have often assumed that productivity is a good measure of well-being. Lehman and Hurnik have suggested that longevity may be a reasonable means of assessing the suitability of the animal's environment. Others have proposed that stress may be determined by measurement of certain physiological parameters, by behaviour and by some measure of the desires of the animal. Surely, however, the desires of an animal may not necessarily reflect needs.

These various aspects are mentioned only to indicate to some degree the scope of the problem and the difficulty in finding common ground. This is not to say, however, that such common ground cannot be found.

Steps already taken in this direction include the publication of Codes of Practice for poultry and pig production. These codes have been produced by the cooperative effort of animal welfarists, researchers in university and government, and animal producers. This approach must be continued and broadened.

Inasmuch as Codes of Practice have already been written and others are under study and preparation, one would have to conclude that the welfare movement has already had an impact on animal production. What are some of the areas where the influence of welfare demands may be seen in the future in animal production?

1. Housing

(a) Veal calf

It is common knowledge that there is considerable concern with regard to the individual housing of veal calves. The chaining of these calves is regarded by some as unacceptable. It may well be that further research will demonstrate that our present housing methods are indeed humane and without undue stress, indeed there is good reason to believe such is the case, but it is also a distinct possibility that the present form of housing of veal calves will have to be altered. The raising of such calves in groups and/or the discontinuance of white veal production are two possible results.

(b) Sows

The use of individual gestation stalls and the normal farrowing crate is another area where welfarists have expressed concerns. Tethering of sows is yet another example which has brought forth strong opposition. As a result, research is underway in several places attempting to find suitable and reasonable replacements for this form of housing. The question of exercise, the question of the animal being able to turn, lie down, stand up, groom itself, and so on, are all factors which should be considered. There is concern with regard to the effect of concrete on both mature swine and the knees and nipples of the baby piglets. Once again, research into these factors could result in housing changes, the use of bedding and hence a change in manure handling.

(c) Hens

The question of whether it is suitable to house egg producing hens in cages has long been discussed. Once again work is underway to determine whether this housing is acceptable and to find means of measuring the degree of acceptability and also to alter the type of cage being used to make it more acceptable. Many different forms of housing for hens are being studied including so-called percheries, and attempts to determine the degree of stress in hens housed in varying conditions continue.

2. Transportation

A great deal of work has been done in recent years in the development of facilities and procedures for the transportation of livestock. A recent survey in the United States showed that many of the holding facilities, loading chutes and penning arrangements involved in the transportation of livestock are unacceptable. They are unacceptable from a humane standpoint and also from an efficiency standpoint. Improvements would result in less labour, less bruising, less stress on both humans and animals, and an improved product. Many simple things can be done at minimum expense to improve our transportation procedures. Adjustable loading ramps, curved chutes, solid partitions in chutes, proper gates, are but a few inexpensive items which would result in marked improvement.

3. People .

It may well be that more attention will have to be given to the type of individual hired to handle livestock. Not everyone is suited to the frustrations and problems involved in livestock production and transportation. In addition, suitable people will also have to be properly trained. Pressure from both the standpoint of good husbandry and the people in the welfare movement will necessitate the use of well-trained individuals. From observation, it seems that even the most rudimentary knowledge of animal behaviour is lacking in many of the people presently employed as drovers and the like. A recent television program showed a truck driver walking on the backs of pigs crowded on a tractor trailer and indiscriminately using an electric prod on pigs that had no where to go but up. The removal of such people from involvement in livestock production and livestock handling must occur.

4. Research

A great deal more needs to be known concerning items that are stressful for the animal being kept for food. Certainly the anthropomorphism seen in many articles on the subject needs to be replaced with sound data. Progress is being made and it will continue.

5. Conclusion

All of us in the industry need to take whatever steps seem appropriate at the level in which we are involved to bring about improvements. The pressure being exerted by welfare groups is not all negative. Industry can grow and improve as a result of the questions being raised by these concerned people and the final result can be an improved and stronger animal industry.

Suggested Readings and Source Material

Ruth Harrison, 1964. Animal Machines. Vincent Stuart Ltd., London.

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James Mason and Peter Singer, 1980. Animal Factories. Crown Publishers Inc., New York.

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NUTRIENT UTLIZATION AND DISPERSION IN ANIMAL FEEDS

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Introduction

The purpose of all persons associated with rearing livestock is (or should be) to provide them with the best possible nutrition. To this end, nutritionists formulate feeds, mill personnel in the mill or on the farm manufacture the feed, and producers of the livestock feed it! In this chain of events, the truth is that not all feed manufacturing equipment or personnel are capable of the precision demanded by scientifically advanced formulations.

We have all heard phrases in the industry as follows:

> What is the digestibility of ...?
> Adjust the amino acids to account for availability.
> Add tallow to sow diets.
> Remember the lysine:arginine ratio.
> Keep the Ca:P ratio within range.
> Make sure every mouthful is the same as the next.
> Are the vitamin levels adequate?
> Maybe I need more biotin!

On paper, all of the above comments and many more like them can be addressed. With adequate quantities of quality ingredients, as is the case in most feed mills today, nutritionists can formulate scientifically sound diets to maximize performance and profitability. However, the question still remains: Do all of the nutrients get to all of the animals all of the time in the quantities and form intended?

In the remainder of this talk, I want to illustrate the following:

1. **Grind of grains** - How to evaluate the usefulness of this evaluation.
2. **One physical parameter of ingredients used in feed** - The effect it has on nutrient homogeneity.
3. **Mixer efficiency testing** - How to evaluate and the usefulness of this evaluation.
4. **Causes of unsatisfactory mixing.**
5. **Suggestions to improve uniformity** -
    - Amount eaten/day
    - Particle numbers/g of microingredients
    - Mix uniformity.

1. Grind of Grains

How to evaluate and the usefulness of this evaluation.

Favorite questions both on swine farms and at commercial feed mills relating to form of ingredient (particularly grains) are often as follows:

Is this grain ground too fine or too coarse?
Will my pigs efficiently digest this ration?
If this is too fine, will it cause ulcers?

These questions pose several basic problems:

a) How should the "fineness of grind" be meaningfully evaluated?

b) What is too coarse relative to digestibility of grain starch in particular?

c) What is too fine relative to causing or increasing the incidence of ulcers?

In 1983, the First International Symposium on Particle Size Reduction in the Feed Industry was held at Kansas State University. Many aspects of grain processing were discussed. Of help in answering some of the above questions was the presentation of a method (Behnke, 1983) to measure and define particle size of feedstuffs. Simply put, a sample of ground grain is ro-tapped through a series of 14 Tyler Screens. Through a series of calculations, whether manually or on computer, one can estimate Mean Particle Diameter, Particle Surface Area/Gram and Number of Particles/Gram.

Prior to discussing the usefulness of this technique, it must be understood that many, many factors can and do affect the parameters of a grind. Some of them are as follows:

Screen Brand
*Screen Size (Diameter of Holes)
Screen Type (Holes Punched or Drilled)
Screen Pattern
*Screen Condition (Wear)
Hammer Brand
*Hammer Condition
*Tip Clearance (Between Hammers and Screen)
Horsepower of Mill
Revolutions of Mill (RPM's)
*Grain Type and Variety
Grain Moisture
Grain Flow Rate (Tonnes/Hr.)
Air System on Mill

Since this list is long and probably not complete, it is often easier for nutritionists to ignore it rather than deal with or understand it. Yet to ignore it is to ignore a fundamental processing method which undoubtedly affects performance of the animals we attempt to feed properly. In the above list, the parameters presently being explored at CO-OP FEEDS carry an asterisk (*). Some of the results appear in TABLES 1, 2, & 3. To get a better picture, the "SEIVE RESULTS" have been computerized and graphed (A picture is worth a thousand words). The magnitude of the effect of screen size, screen condition and hammer condition are present in the TABLES 1, 2, & 3. This data has and/or can be used to qualify answers relative to ulcer formation and feed efficiency (digestibility).

Over the years there has always been a concern about incidence and/or severity of ulcers in swine. A review of the role of diet in three important gut disorders of swine (including gastric ulcers). (Pouteaux, 1981) concluded that "too fine a grind of grains" was the leading cause of ulcers in swine. A "MODEL" of why this is so is presented in FIGURE A. So, what is too fine? Most research up to 1982 did not define fineness of grind in terms of particle size or particle numbers/gram but rather in terms of screen size (opening). That was kind of like telling you that a sow farrowed but not telling you how many pigs, what weight and what sex. Wu and Allee (1984) looked at some of these more refined parameters. They measured the effect of particle size of corn diets on the incidence of gastric lesions (ulcers) in finishing pigs (TABLE 4). Their work would indicate that mean particle size of corn should exceed at least 465 microns to minimize the incidence and severity of ulcers. They did not include particle numbers per gram in their report. Field experience would suggest that less than 800,000 - 1,000,000 particles per gram is desirable, particularly when wheat and/or corn are fed. More scientifically controlled research needs to be done in this area.

The other aspect to grind (and probably the primary reason for grinding grains) is to break open a whole kernel to expose the starch to enzymes and/or bacteria and protozoa for maximum digestion. Again, many major experiments done in times past have made elegant conclusions about cereal grain digestibility, but only report them as being ground fine, medium and coarse. Wu and Allee (1984) are some of the first researchers to report digestiblities in relation to estimated mean particle size and surface area/gram (TABLE 5). Working with weaning pigs, they demonstrated that diets containing grains of larger particles (1117 microns) and possessing less surface area/gram (58 cm^2/g) were less efficient (F/G). Their experiment demonstrates how proper evaluation of a grind can help correlate the results of processing (grinding) with dry matter, nitrogen or energy digestibility. In this case, all three of these parameters were improved ($P < .05$) when corn diet mean particle size was 524 microns and surface area/gram was 102 cm^2/gram. Larger particles or less surface area was detrimental.

2. One Physical Paramter of Ingredients (Nutrients) Used in Feeds

The effect it has on nutrient homogeneity.

Anytime one refers to nutrient dispersion in feeds, this ultimately implies the dispersion of an ingredient that contains the nutrient in question:

The 'Nutrient' energy comes primarily from wheat, barley, tallow, etc.
The 'Nutrient' protein comes from soybean meal, canola meal, sunmeal, etc.
The 'Nutrient' calcium comes from limestone, dicalcium, phosphate, etc.
The 'Nutrient' copper comes from copper sulfate, copper oxide, etc.
Etc.

DISPLAY 1 is a visual illustration of the relative quantities of carrier, diluent, vitamins and minerals in 1.8 kg of Micro-Mix. This should serve as an ever constant reminder of the relatively small quantities of certain important vitamins and minerals that must be dispersed into a tonne of complete feed.

Different ingredients have varying physical parameters - density, concentration of nutrients, particle numbers/unit weight and textures and the parameter of interest in this discussion is particle numbers/unit weight (particularly of microingredients).

To obtain uniform growth in a flock or group of birds or animals, it would seem logical that a perfectly uniform mix of nutrients would be the ultimate. As background to this discussion, it is of importance to appreciate the variation in growth that can exist. FIGURE B demonstrates the variation between pigs from two litters on one farm; 'same' barn and 'same' feed. The question that must be posed is - How much of this variation is due to genetics, environment, or nutrient variation in feed? Recently, this question has been posed to some personnel in the feed industry. In search of some answers to this question, the following discussion relative to particle numbers/unit weight is required.

Minerals and vitamins (vitamins in particular) can be purchased with quite different numbers of active particles/gram. For example, VITAMIN A SOURCES contain approximately 100,000 active particles/gram, whereas vitamins like RIBOFLAVIN, PANTOTHENIC ACID, PYRIDOXINE and FOLIC ACID are estimated to contain > 1,000,000 particles/gram. It follows then that to increase the probability of 'perfect' nutrient dispersion in a feed, the use of vitamin sources containing more particle numbers/gram would seem logical. This logic, however, is only true to a point (FIGURES C AND D).

In a perfectly mixed feed (coefficient of variation of each nutrient equal to zero) increasing particles of vitamins/gram does increase the probability of each animal getting its daily expected average level of vitamins. As the bird or animal fed, however, begins to eat more feed, the importance of particle numbers/gram declines.

ASIDE: The probability of obtaining the correct amount of a vitamin each day follows the POISSON PROBABILITY DISTRIBUTION of a 'rare and random' event. Hence, using POISON STATISTICS, one can estimate the % deviation expected from a target value (COUNT). In this case, COUNT = AMOUNT EATEN/DAY IN GRAMS X PARTICLES OF VITAMIN IN EACH GRAM OF FEED.

FIGURE C (Vitamin A) demonstrates that during the first days of post-weaning (three weeks old) there is approximately a 10-15% deviation from the average target count. As the pig gets older and eats more, the percent deviation from the expected average target approaches 5% by day 35 post-weaning. If the particle numbers/gram is increased in the vitamin used, i.e. RIBOFLAVIN, the results are shown in FIGURE D. Percent deviation from average target is 5-6% and by day 35, declines to rear 2% as the pig eats more feed/day.

A similar graph (BASF 1985 is presented using three different particle counts) in FIGURE E.

Not to confuse this subject, but worthy of presentation is FIGURE F. (BASF, 1985) This figure demonstrates the POISSON PROBABILITY at different CONFIDENCE INTERVALS 66.67, 77.78, 88.89 and 100. FIGURES C, D, & E were presented at the 95% CONFIDENCE INTERVAL.

Thus, the less an animal eats/day or the fewer the particles of a vitamin in the feed, the greater is the probability that the animal will get too much or not enough of that vitamin. All of this has been said to emphasize that these concepts can be quantified and graphically displayed. From this information, the physiological consequences can be estimated or debated.

3. Mixer Efficiency Testing

How to evaluate mixers and the usefulness of this evaluation.

The previous discussion on particle numbers and daily feed intake assumed a perfect or uniform blend of nutrients. This is not always the case and presents a further source of error or deviation from a target daily level.

Profiling for uniformity involves at least two important checks on the quality of any mixing operation.

1. **THE MIXER** - Evaluation requires that a minimum of 10 samples of approximately 100 grams (1/4 lb.) be taken either:

   (a) from 10 different probes of a finished mix.

   (b) at 10 equal intervals as the batch passes an access point immediately after discharge from the mixer. Hence, if it takes three minutes (180 seconds) to empty a mixer, a sample must be taken every 18 seconds to obtain a profile.

   The samples obtained can be assayed for such nutrients as sodium (salt), manganese or riboflavin. After obtaining the assay values a "coefficient of variation" (C.V.) for that nutrient should be determined. An example is shown in TABLE 6.

   FIGURES G, H, & I (Wilcox, 1985) demonstrate how the "COEFFICIENT OF VARIATION" principle can be applied to determine proper mixing times for different designs of mixers.

   According to McEllhiney (1983) once a 'good' mixer (C.V. less 10%) is discovered (and a proper mix time determined) very small quantities of ingredients can be mixed uniformly. Conversely, a poorly designed mixer will never mix uniformly regardless of quantities of ingredients used (TABLE 7).

   If one combines the 10% C.V. due to mixing, with variation due to particle numbers and amount eaten/day for Vitamin A it is obvious that it is 95% probable that young newly weaned pigs can experience either approximately a 25% overage of Vitamin A each day or approximately 20% underage (FIGURE C). The figures are similar but not as dramatic for RIBOFLAVIN (FIGURE D). Maybe this is why some swine producers feel it is beneficial to add water soluble vitamins via a water medicator to newly weaned pigs. This technique may help ensure uniform vitamin supplies to this age class of swine.

The message here is that nutrient variation due to mixing can be important and mixer manufacturers suggested mixing times may not be sufficient (TABLE 8). Test mixers appropriately and help minimize nutrient variation in the feeds you sell or use. Again, once mixer variation is quantified, the physiological consequences of such can be estimated or debated.

2. **THE CONVEYING SYSTEM** - Testing this system is to be done after and only after acceptable profiles (C.V.'s) can be demonstrated from the mixer. Evaluation here requires that a batch of feed can be sampled at least twice; once just as it leaves the mixer and once just prior to pelleting or packaging or the final bin or before feeding. The resulting assays should be compared for uniformity.

4. Causes of Unsatisfactory Mixing

(a) Poor choice of mixer design - horizontal ribbon mixers are preferred to vertical single screw mixers. An acceptable % C.V. is usually obtained with normal mixes in a horizontal mixer in approximately four minutes (FIGURE J).

Kansas State Research indicates that PTO vertical mixers can reach a satisfactory mix at 17 minutes (TABLE 9). However, vertical mixers have a tendency to mix and then unmix. A stationery vertical mixer may obtain a satisfactory mix at 12 minutes (TABLE 9), but turn unacceptable by 19 minutes and never return to acceptable levels (TABLE 9).

(b) Choice of inadequate mixing time - as demonstrated above different designs of mixers have different optimum mixing times. Usually, the only way to determine optimum mix times is trial and error.

(c) Other Signs of Mixer Problems:

Horizontal mixers - (FIGURE J)

- Ribbons covered during mixing.
- Buildup at one end during mixing.
- Bent, broken, or missing ribbons.
- Unnecessary buildup on shaft or ribbons.
- Undue clearance between ribbons and mixer wall.

Vertical Mixers (FIGURE K)

- No door to observe mixer action.
- Badly worn vertical screw. (Never able to mix properly.)
- Unnecessary buildup on screw.
- Overfill.

(d) Selection of Improper Order and Levels of Ingredient Additions

The sequence of addition of ingredients and additives to the mixer can affect the ease with which a component is blended into the total mix. Generally, vitamins and trace minerals should not be added singly to a large mixer during complete feed or supplement manufacture. During addition of ingredients to a mixer, it is not wise to add Micro-Mixes or Premixes first under any conditions. Always remember that mixing time doesn't officially start until the last ingredient is in the mixer.

(e) Inadequate or inaccurate weighing equipment.

(f) Irresponsible operator of weighing and mixing equipment.

(g) Electrostatic hang-up.

(h) Segregation (separation) after mixing

Segregation is the separation of one or more ingredients or fraction of an ingredient from the remainder of the mix.

A typical chain of events may be as follows: Feed satisfactorily mixed in mixer, slightly segregated as it drops into a surge bin, somewhat remixed in the surge bin auger and elevator leg, markedly segregated in the free air fall unto the holding bin (what goes up, must come down) over the pellet mill, and partially remixed in the outflow from the bin and in the pellet mill conditioning chamber. Whatever degree of uniformity exists at this point is preserved in the pellets. Along the chain of events, dust collecting systems can aspirate off fine particles including vitamins, and this dust may be returned uniformly back to the feed.

5. Suggestion to Improve Mix Uniformity

- Grind ingredients to an appropriate particle size.
- Use liquids (fat, molasses, water) to agglomerate particles.
- Process to a uniform particle shape (flaked oats and salt do not flow well together).
- Generally, the finer the particle size, the less segregation occurs due to density differences.
- Increase particle numbers/unit weight of microingredients where appropriate.
- Eliminate high free fall of feed. Small tubes or slides in high bins may be useful (FIGURE L).
- Limit the number of times a feed has to funnel from a bin. Martin (1983) indicated that the "C.V." of a uniform mix can increase 3 to 4% from a free fall into a bin and subsequent funnelling from the bin into a pellet mill, bagger, or feed trough (FIGURE L).
- Generally, belt conveyors are superior to drag conveyors which are superior to screw conveyors at maintaining the integrity of a mix.

Summary

Nutritionists strive to formulate rations containing adequate quantities and optimum balances of nutrients (ingredients) to maximize performance of animals and on farm profits. It is, however, unfortunate that the effect of processes (grinding) to which ingredients are subjected are often poorly quantified and hence, poorly correlated with physiological responses. Also, the search for scientific knowledge about nutrients (availability, interactions and requirements) can demand accuracy beyond which current manufacturing or mixing technology can or is used to providing. Researchers also ought to be keenly aware that minimizing nutrient variation in test diets is a prerequisite to obtaining valid and correct experimental nutritional data from which nutrient recommendations are based. All individuals involved in the feeding of livestock and poultry must appreciate the importance that proper ingredient use and nutrient dispersion can play in producing food from feed.

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Feed:Poute:jg

TABLE 1

Effect of Screen Size on Particle Size Reduction Parameters*

	Mean Particle Diamter (Microns)	Surface Area (cm^2/Gram)	Particles/Gram
Barley			
7/64" (2.78 mm)	577	292	222,840
8/64" (3.18 mm)	588	287	295,460
(Diff.)	(1.02 X)	(1.02 X)	(1.33 X)
Wheat (HRSW)			
7/64" (2.78 mm)	484	310	961,490
8/64" (3.18 mm)	617	229	246,800
(Diff.)	(1.28 X)	(1.35 X)	(3.90 X)

*Partially Worn Screen (Brand Y)
Partially Worn Hammers
100 HP - 3400 RPM Tear-Drop Circular Hammer-Mill
Feed Mill #7

CO-OP FEEDS (1985)

TABLE 2

Effect of Screen Condition on Particle Reduction Parameters*

	Mean Particle Diamter (Microns)	Surface Area (cm^2/Gram)	Particles/Gram
Peas			
New	646	179	130,480
Worn	344	355	1,132,500
(Diff.)	(1.88 X)	(1.98 X)	(8.68 X)
Barley			
New	692	229	118,200
Worn	388	419	311,400
(Diff.)	(1.78 X)	(1.83 X)	(2.64 X)
Wheat (HRSW)			
New	772	186	73,290
Worn	358	427	938,200
(Diff.)	(2.16 X)	(2.30 X)	(12.8 X)

*7/64" (2.78 mm) Screen (Brand X)
Partially Worn Hammers
100 HP - 3600 RPM Tear-Drop Circular Hammer-Mill
Feed Mill #8

CO-OP FEEDS (1985)

TABLE 3

Effect of Hammer Condition on Particle Size Reduction Parameters*

	Mean Particle Diamter (Microns)	Surface Area (cm^2/Gram)	Particles/Gram
Peas			
New	399	393	2,244,800
Worn	417	397	1,659,100
(Diff.)	(1.05 X)	(1.01 X)	(1.35 X)
Barley			
New	633	274	180,700
Worn	627	250	124,100
(Diff.)	(1.01 X)	(1.10 X)	(1.46 X)
Wheat (Winter)			
New	443	390	2,319,500
Worn	433	392	1,841,900
(Diff.)	(1.02 X)	(---)	(1.26 X)

*7/64" (2.78 mm) New Screen (Brand Z)
100 HP - 3600 RPM Tear-Drop Circular Hammer-Mill
Feed Mill #8

CO-OP FEEDS (1985)

TABLE 4

Effect of Particle Size on Corn Diets on Incidence of Gastric Lesions in Finishing Pigs

	Hammermill Screen Size (in.)		
	4/64"	16/64"	32/64"
Corn Mean Particle Size (Microns)	465	820	1,363
Corn Surface Area (cm^2/g)	110	72	52
# of Pigs	8	8	8
# of Normal Stomachs	0	4	5
# of Cornifications	2	3	3
# of Erosions	2	1	0
# of Slight Ulcers	3	0	0
# of Serious Ulcers	1	0	0

From: Wu and Allee (1984)

TABLE 5

Effect of Particle Size and Surface Area of Corn Diets on Performance and Apparent Digestibilities for Weaning Pigs

Item					
	Screen (in.)	1/16	1/4	1/2	
	Diameter (microns)	524	864	1,117	SE
	Surface Area (cm^2/g)	102	68	58	
Average daily gain, lb		.77	.84	.79	.04
Daily feed intake, lb		1.23	1.43	1.39	.07
Feed:gain		1.57[b]	1.68[bc]	1.75[c]	.05
Dry matter,[a] %		85.75[b]	83.85[c]	83.37[c]	.37
Nitrogen,[a] %		85.22[b]	82.95[c]	82.58[c]	.29
Energy,[a] %		86.07[b]	83.21[c]	82.50[c]	.36

[a] Dry matter basis.

[bc] Means of the same line with different superscripts differ ($P < .05$).

From: Wu and Allee (1984)

TABLE 6

DISCHARGE OVER 180 SECONDS FROM WHICH 10 SAMPLES WERE TAKEN AND ASSAYED FOR RIBOFLAVIN.

RIBOFLAVIN, MANGANESE, ETC.
GRAMS/KG
3.09
2.98
2.97
2.70
2.83
2.99
3.10
3.08
3.10
2.92

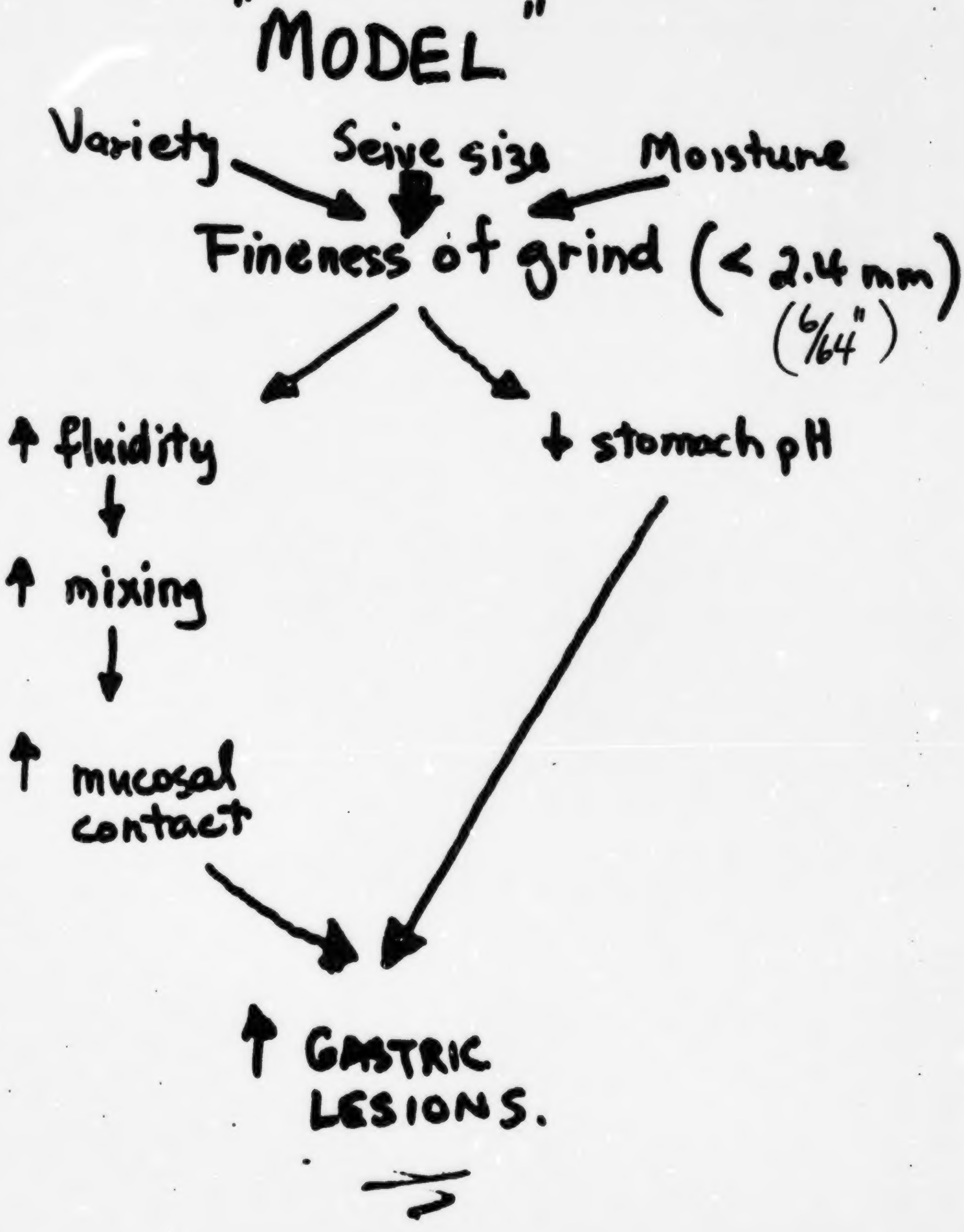
FOR EASE OF CALCULATION, USE A CALCULATOR WITH BUILT-IN MEAN AND STANDARD DEVIATION KEYS. OTHERWISE, CONSULT WILCOX AND BALDING BULLETIN OR A STANDARD STATISTICS TEXTBOOK FOR EXPLANATION OF HOW TO CALCULATE $\bar{X}$ AND σ.

MEAN (AVERAGE) = $\bar{X}$ = 2.976 GM/KG
STANDARD DEVIATION = σ = .131

$$\% \text{ COEFFICIENT OF VARIATION} = \boxed{CV = \frac{100\ (\sigma)}{\bar{X}}} = \frac{100\ (.131)}{2.976} = 4.4\%$$

$CV < 5\%$ = HIGHLY ACCEPTABLE, PREFERRED FOR CHICKS, POULTS, HEANLINGS.
$CV \leq 10\%$ = ACCEPTABLE FOR OTHER CLASSES OF LIVESTOCK.
$CV > 10\%$ = EFFORTS TO IMPROVE MIXING ARE DESIRABLE.

FIGURE A


"MODEL"
Variety
Seive size
Moisture
Fineness of grind (< 2.4 mm) (6/64")
↑ fluidity
↑ mixing
↑ mucosal contact
↓ stomach pH
↑ GASTRIC LESIONS.

POUTEAUX (1981)

FIGURE B

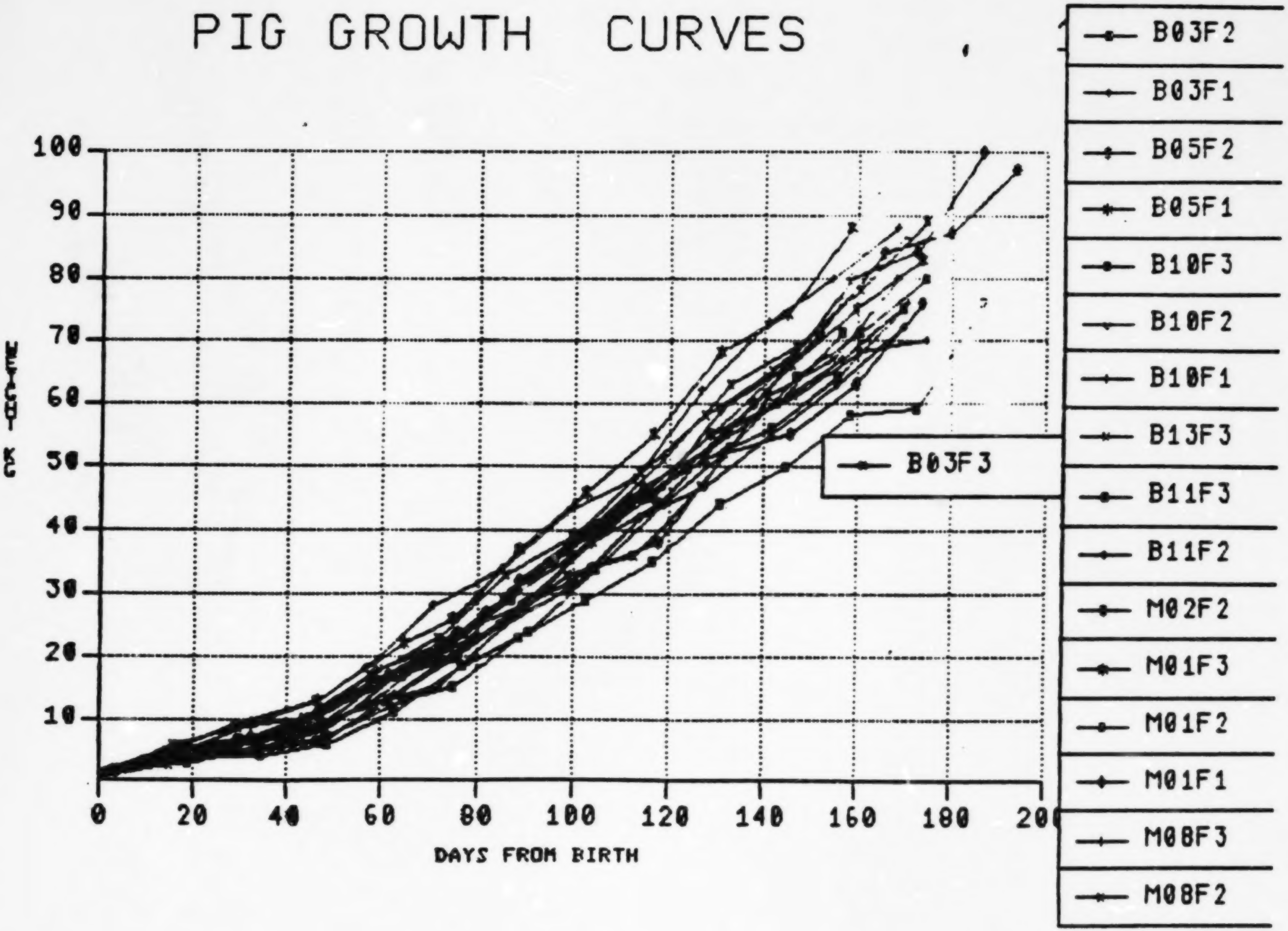
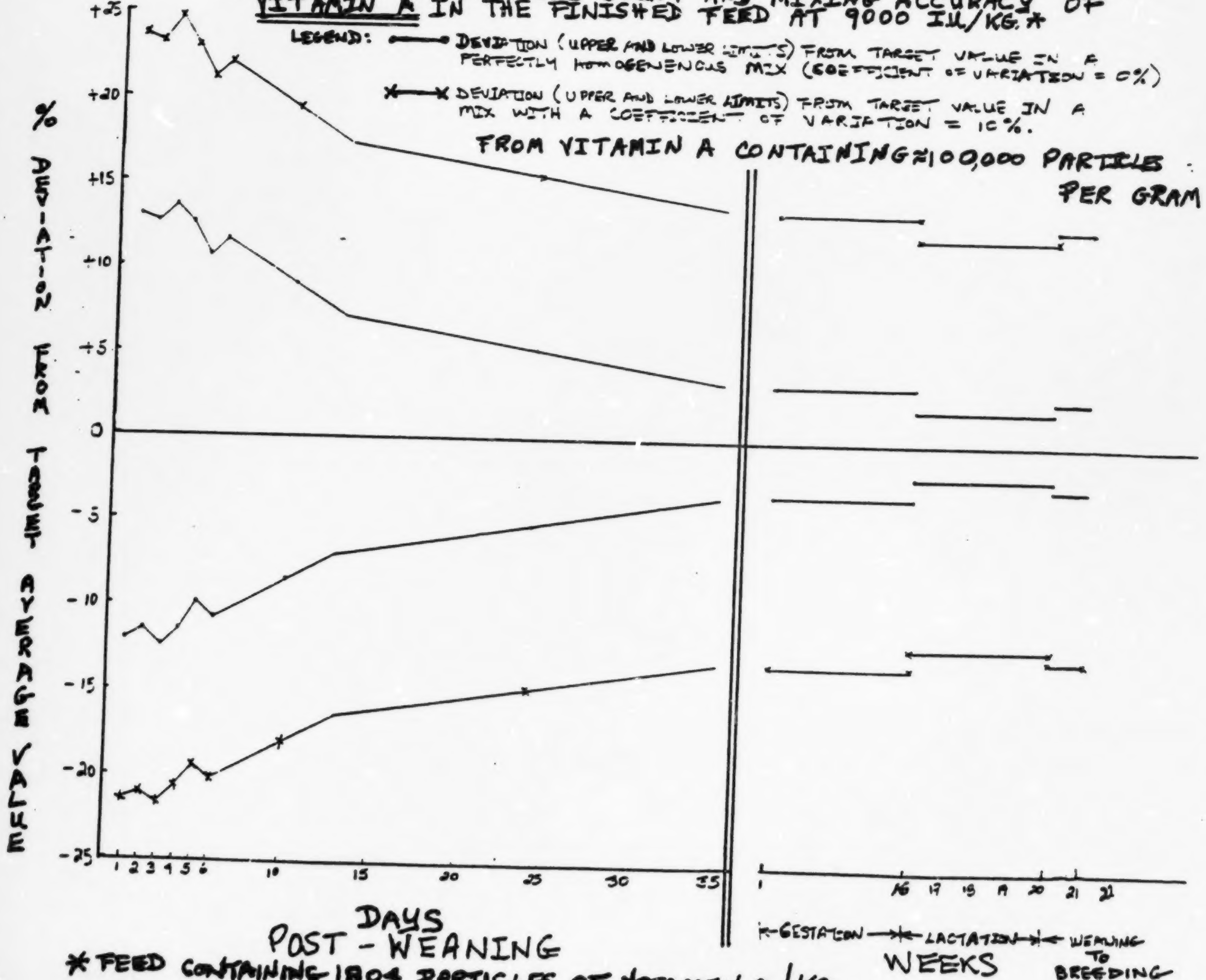

PIG GROWTH CURVES
WEIGHT KG
100
90
80
70
60
50
40
30
20
10
0
20
40
60
80
100
120
140
160
180
200
DAYS FROM BIRTH
B03F3
B03F2
B03F1
B05F2
B05F1
B10F3
B10F2
B10F1
B13F3
B11F3
B11F2
M02F2
M01F3
M01F2
M01F1
M08F3
M08F2

FIGURE C

SWINE RATIONS

95% CONFIDENCE INTERVAL FOR DEVIATION FROM TARGET VALUE.

THE EFFECT OF PARTICLE COUNT AND MIXING ACCURACY OF VITAMIN A IN THE FINISHED FEED AT 9000 IU/KG.*



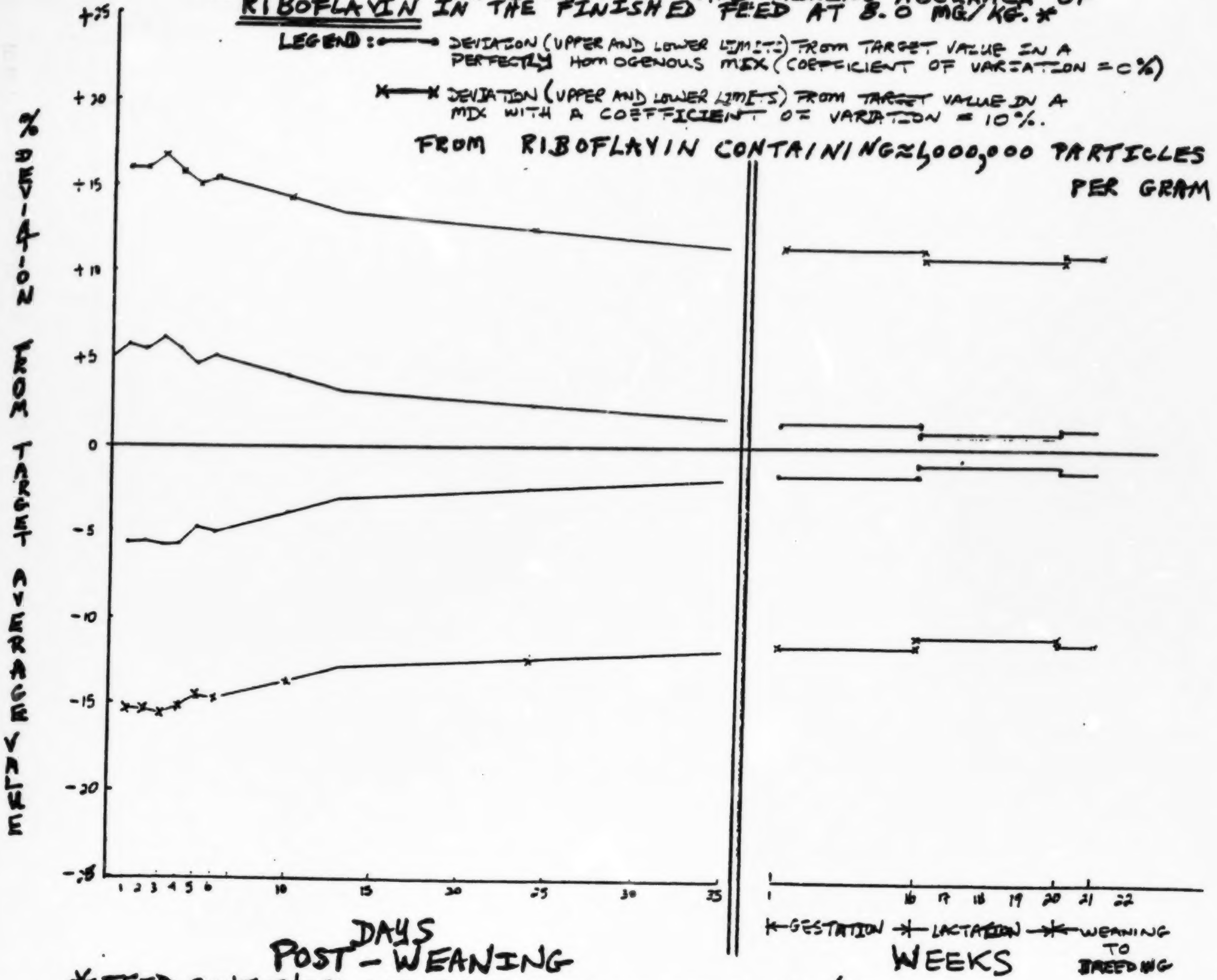
* FEED CONTAINING 1804 PARTICLES OF VITAMIN A/KG.
COOP-FEEDS 1985

FIGURE D

SWINE RATIONS

95% CONFIDENCE INTERVAL FOR DEVIATION FROM TARGET VALUE.

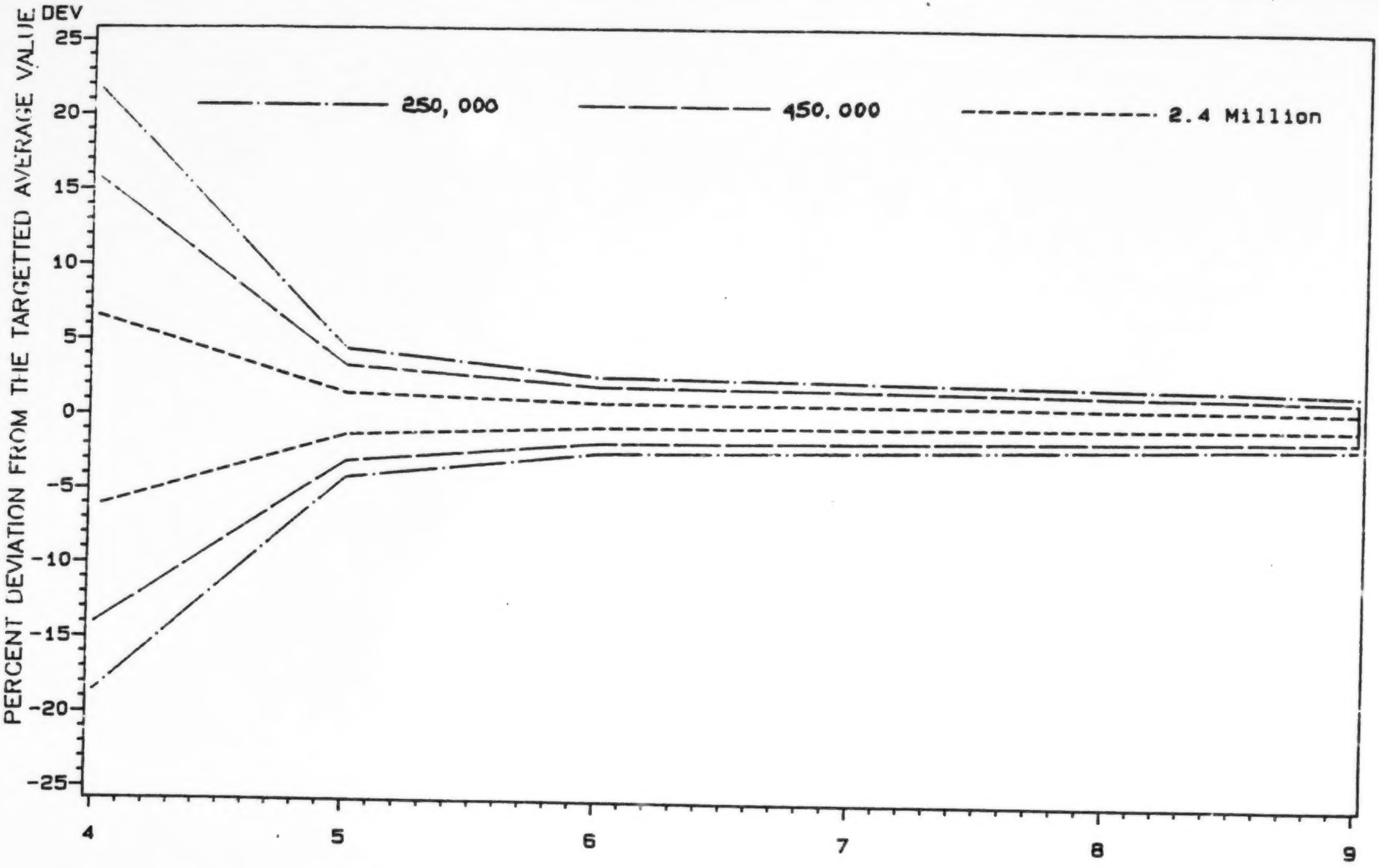
THE EFFECT OF PARTICLE COUNT AND MIXING ACCURACY OF RIBOFLAVIN IN THE FINISHED FEED AT 8.0 MG/KG.*



* FEED CONTAINING 8430 PARTICLES OF RIBOFLAVIN/KG.

FIGURE E

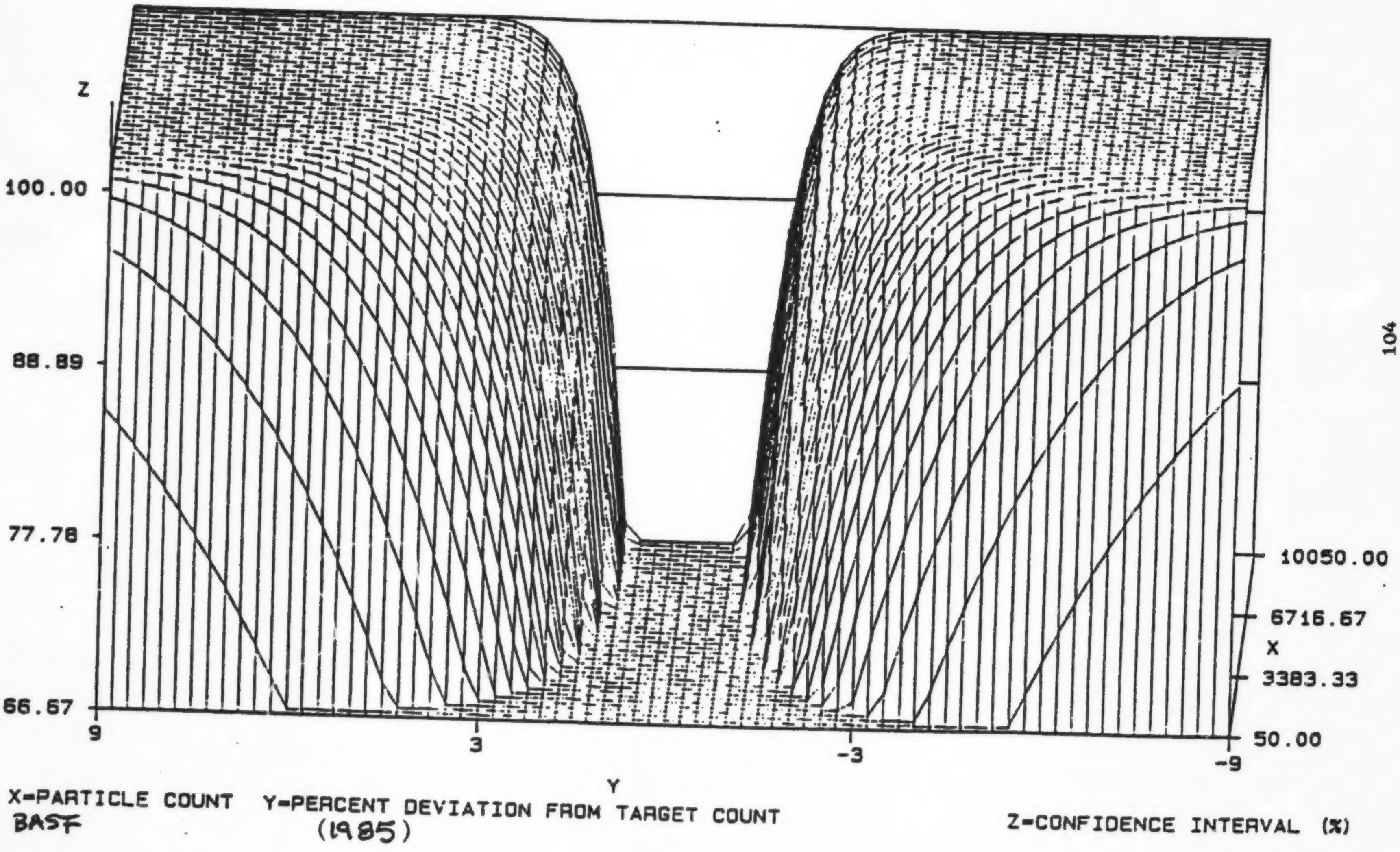
DAILY SWINE RATIONS
95% CONFIDENCE INTERVAL FOR DEVIATION FROM TARGET VALUE
The effect particle count of vitamin E source at a finished feed level of 20 iu/kg



BASF (1985)

FIGURE F

THE POISSON PROBABILITY CANYON



BASF

(1985)

FIGURE G

HORIZONTAL RIBBON MIXER

3-TON

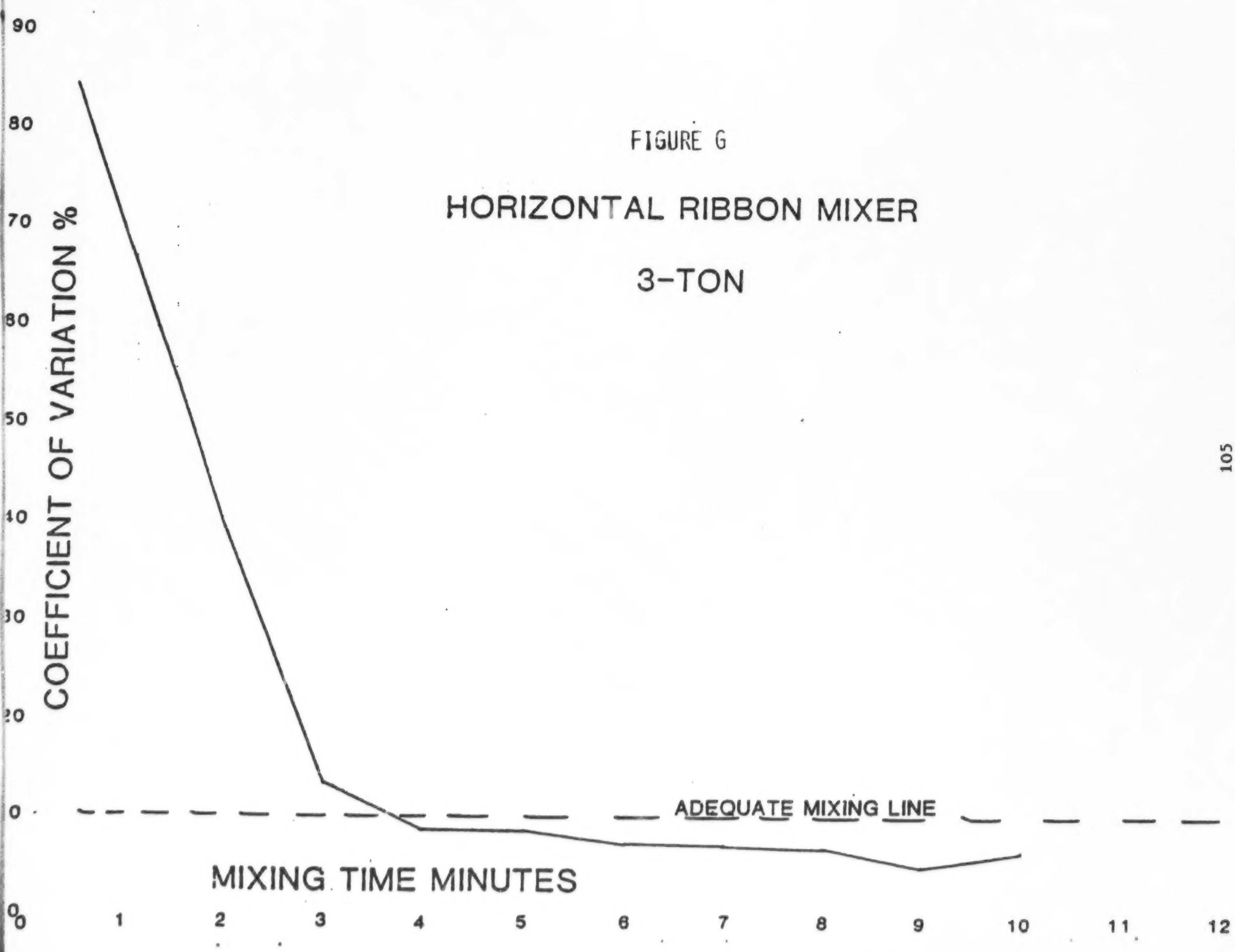
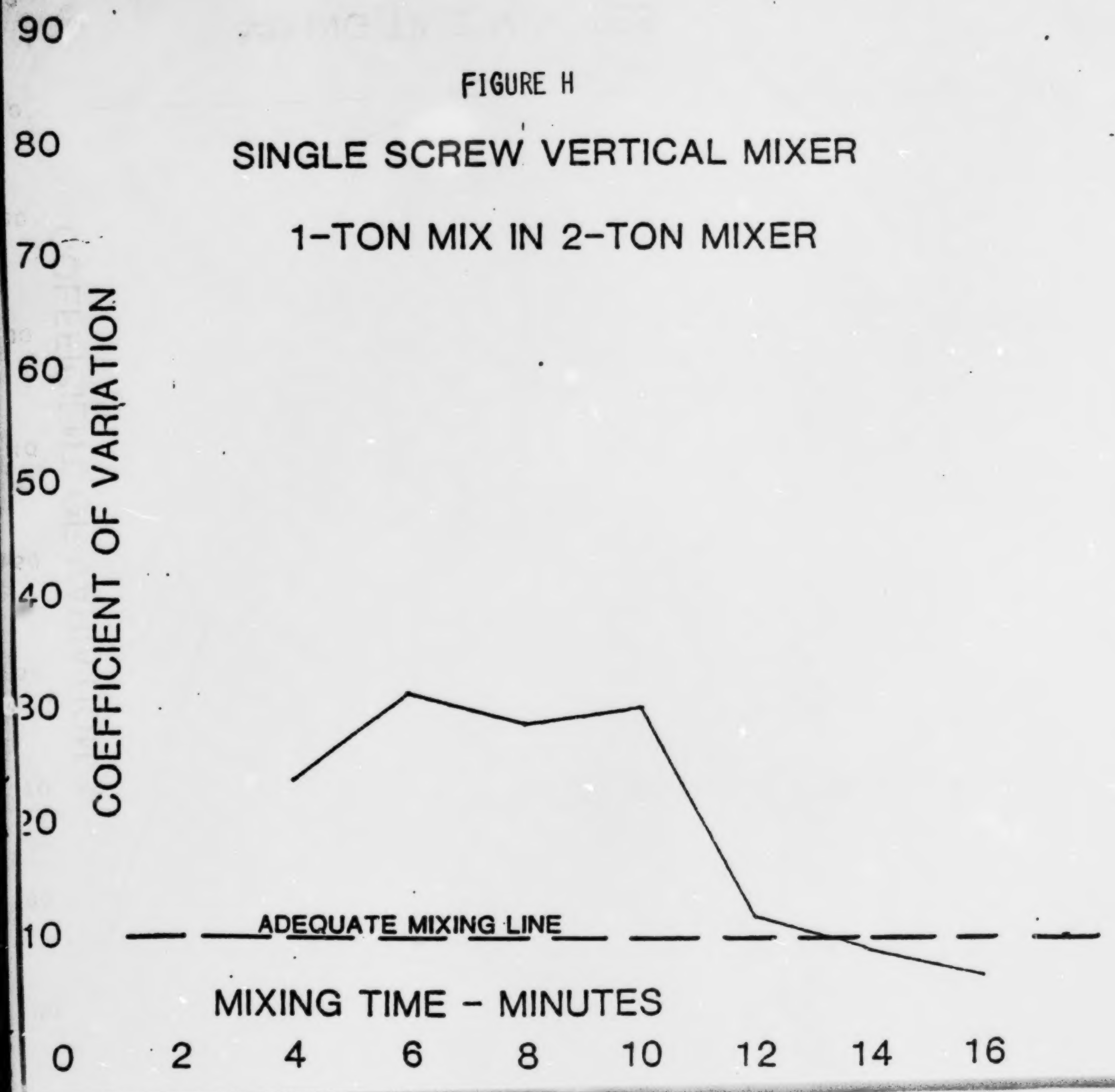


FIGURE H


SINGLE SCREW VERTICAL MIXER

1-TON MIX IN 2-TON MIXER

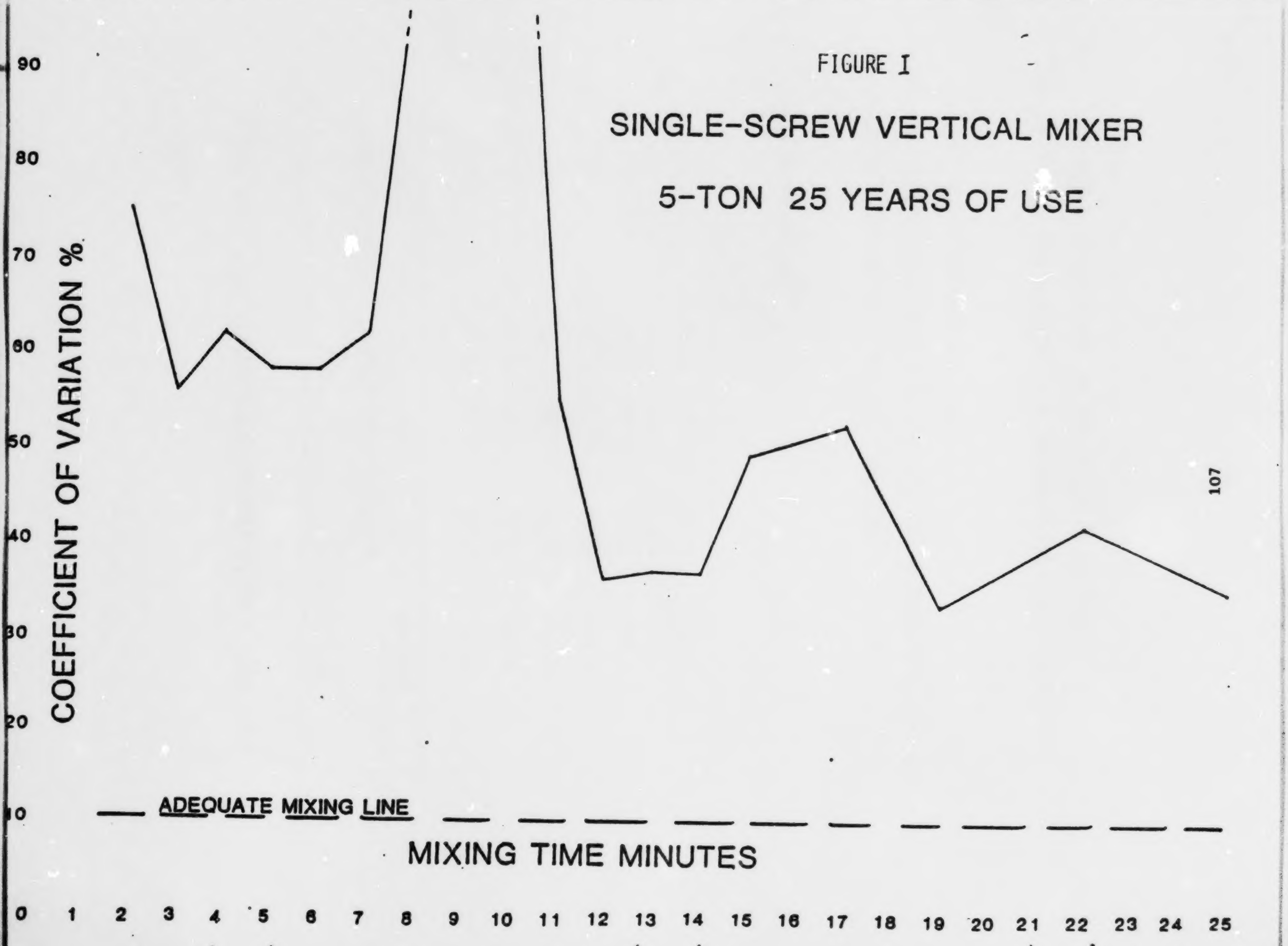


FIGURE I

SINGLE-SCREW VERTICAL MIXER

5-TON 25 YEARS OF USE

TABLE 7

MIXER TESTS (1) - PORTABLE PTO GRINDER-MIXER - IOWA 1983

PACKAGE SIZE(2) (POUNDS)	% OF COEFFICIENT OF VARIATION MIXING TIME (MINUTES) 5	10	15	AVERAGE
5	39.2	41.5	56.2	45.6
10	43.8	41.7	38.9	41.5
25	37.1	48.2	58.3	47.9
50	54.3	56.8	14.9	42.0
300	39.4	54.5	58.1	50.7
AVERAGE	42.8	48.5	45.2	45.5 (3)

(1) QUANTAB METHOD.

(2) FINELY GROUND CORN AND SALT PREMIXED. THE SALT LEVEL IN THE FINAL BLEND WAS .25% FOR THE 5LB PACKAGE AND .50% FOR THE REMAINING PACKAGE SIZES.

(3) A SECOND NEW PORTABLE PTO GRINDER-MIXER WAS TESTED AND SHOWED A COEFFICIENT OF VARIATION OF 50.39%.

TABLE 8

MIXER MANUFACTURER'S SUGGESTED MIXING TIMES

(From their literature)

Manufacturer	Type	Mixing time
A	Horizontal	1.5 minutes after adding premix and soy plus 3 minutes after adding grain
B	Horizontal	1 to 4 minutes after last ingredient added
C	Vertical	Several minutes
D	Vertical	Mixing more than 10 minutes causes particle separation
E	Vertical	Several minutes
F	Vertical	3 to 5 minutes after last ingredient added
G	Vertical	15 to 20 minutes for 1 to 2 ton batch
H	Vertical	Several minutes
I	Vertical	2 to 5 minutes after tank is full

FROM: Reese, UNL - 1985
AS REPORTED BY: WILCOX (1985)

TABLE 9

MIXER TEST RESULTS - KSU EXTENSION (MAY 1983)

	QUANTAB TESTS - % COEFFICIENT OF VARIATION (1)	
MINUTES (2)	IH MODEL 1250, 5000# CAP. P.T.O. ON-FARM MIXER	KELLEY 5000# CAP. VERTICAL STATIONARY MIXER
1		
2		
3	19.1	49.0
4		45.0
5	12.7	55.0
6		36.0
7	12.6	22.0
8		16.0
9	9.4	6.13 *
10		9.73
11	11.4	10.63
12		3.7
13	10.9	5.0
14		6.46
15	9.0	8.95
16		7.72
17	4.4 *	5.2
18		9.0 *
19	7.8	14.45
20	4.1	15.08
21		12.06

(1) A. C.V. OF 8.0% OR LOWER IS ACCEPTABLE.

(2) MINUTES AFTER LAST INGREDIENT, SALT, ADDED.

FIGURE J

Incomplete Mixing—Horizontal Mixer

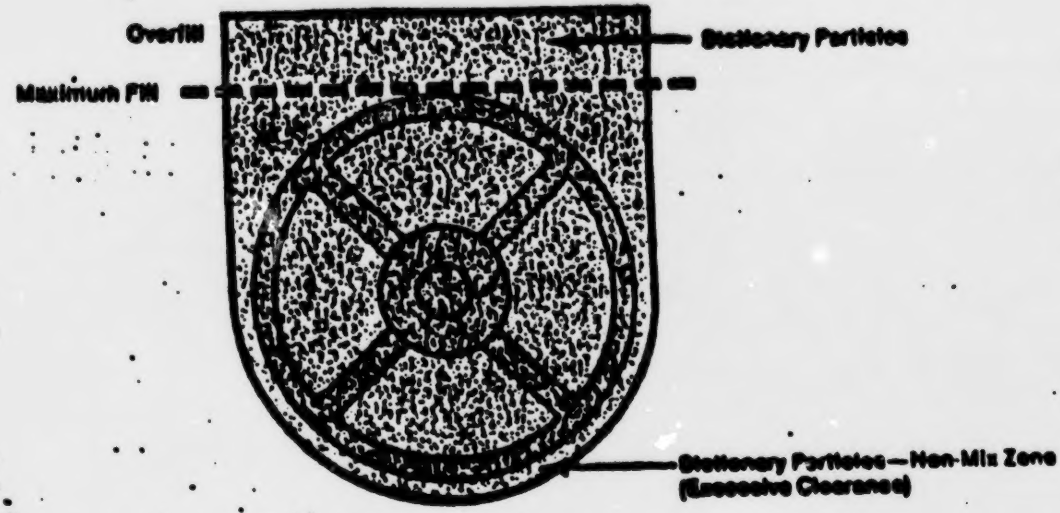

Overfill
Stationary Particles
Maximum Fill
Stationary Particles—Non-Mix Zone (Excessive Clearance)

FIGURE K

Incomplete Mixing—Vertical Mixer
(Insufficeint Mixing Times)

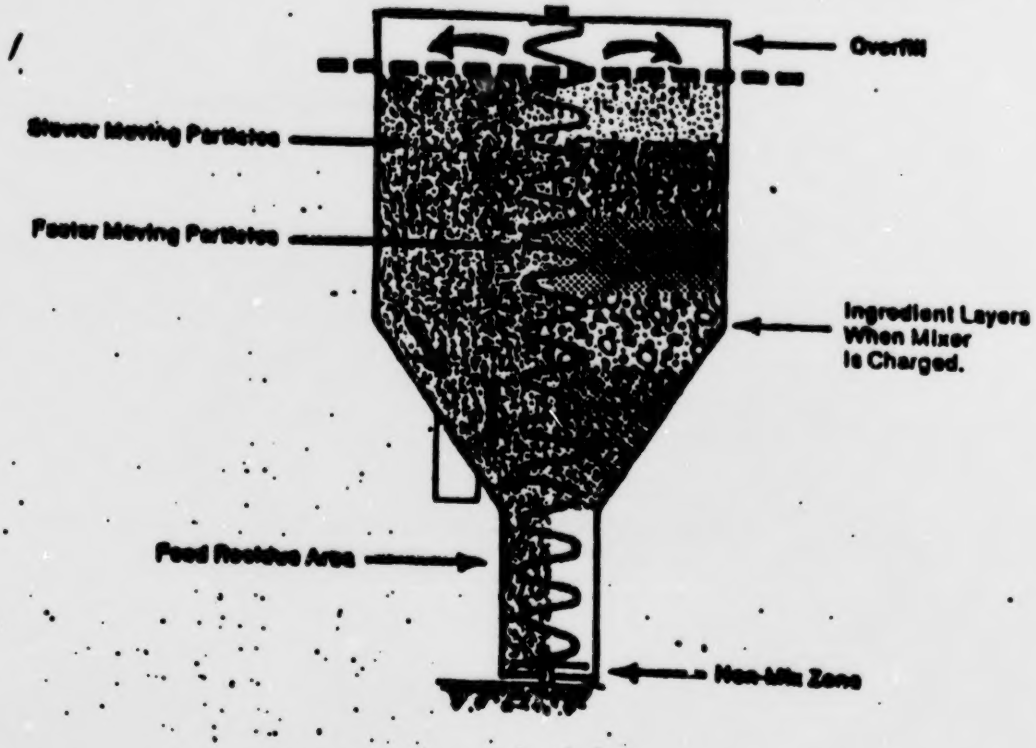
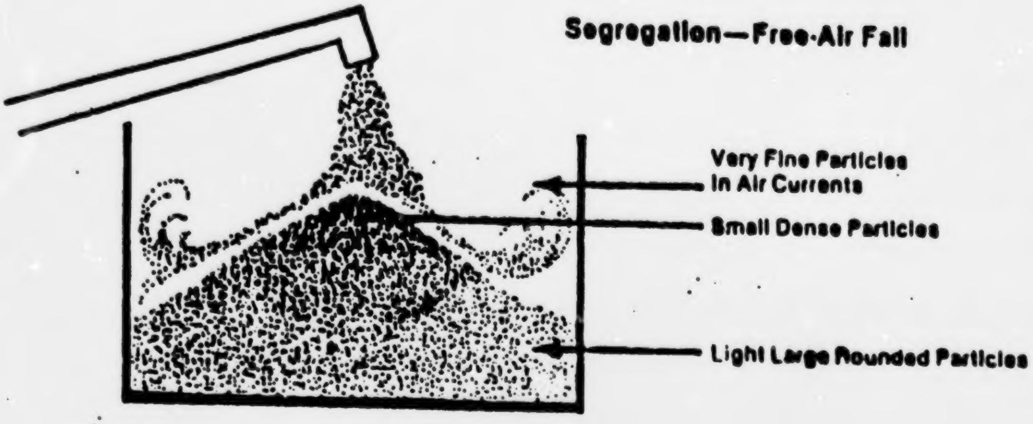

Overfill
Slower Moving Particles
Faster Moving Particles
Ingredient Layers When Mixer Is Charged.
Feed Residue Area
Non-Mix Zone

FIGURE L


Segregation—Free-Air Fall
Very Fine Particles In Air Currents
Small Dense Particles
Light Large Rounded Particles

THE CANADIAN RED MEAT INDUSTRY: DOMESTIC POLICIES AND BORDER PROBLEMS WITH THE EC AND THE USA

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Introduction

This past year has been an eventful one for the red meat industry in Canada. The beginning of the year was marked by a vigorous protest by the EC over its share of Canada's beef import quotas. The Honorable John Wise succeeded in obtaining enabling legislation relating to a tripartite price support policy for the red meat industry; this legislation has still to be implemented because of difficulties encountered with several of the provinces. On July 25, 1985, a final ruling was made by the USA to impose countervailing duties on Canadian live hog exports to the USA. Recently, the Canadian Cattlemen's Association requested the federal government to place countervail duties on EC exports of boneless beef to Canada.

All of these events have left the Canadian red meat industry in a very uncertain situation. It is clear that many serious and unresolved issues have emerged on the domestic policy/international trade front.

We will return to these issues for a more detailed analysis, but first we must examine some of the background history relating to the evolution of Canadian policies associated with the red meat industry in Canada.

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[1] Prepared for presentation to the Manitoba Annual Animal Industry Conference, Winnipeg, Manitoba, December 10, 1985.

Assessment of Canadian Policies Relating to the Red Meat Industry

The debate over domestic policy options in the red meat industry has had a long and checkered history in Canada. Perhaps, the most vigorous debate occurred with the introduction of Bill C-176 in the House of Commons in 1971 with the proposal to establish the Farm Products Marketing Agencies Act. This Act originally provided that cattle and hogs should be included in the comprehensive supply management program included under the Act. For well over a year a barrage of criticism was focused on this Act by a number of organizations including the Canadian Cattlemen's Association, the Saskatchewan Stock Growers' Association, and the provincial hog marketing boards in Alberta, Saskatchewan and British Columbia. After a long and bitter controversy, an amendment to Bill C-176 in late 1971 provided that cattle and hogs would not be included in the Bill.

If the majority of cattle and hog producers did not want a comprehensive supply management policy for their sector, what policy, if any, were they prepared to support? It appears that the cattle and hog producers were prepared to support the Agricultural Stabilization Act providing that certain amendments were made to the Act. After lengthy debate, the Agricultural Stabilization Act was amended in 1975. Two of these amendments should be noted:

1. The first major amendment provided that price supports would be based on 90% of the previous 5-year average prices, and that the calculated support price would be further adjusted by an index reflecting changes in the cash costs of production.

2. Another amendment in the Act provided that the provinces could "top load" the federal price support formula if any given province decided that a higher level of price support should be provided to its producers.

Because of the high level of inflation which followed the amendments to the Agricultural Stabilization Act in 1975, cattle and hog producers soon discovered that the price supports calculated under the amended Act did not keep pace with the rapid increases in their own costs of production. It was not surprising that producers soon petitioned for still further amendments to the act to provide for price supports that more nearly reflected the rapid increases in their production costs.

After prolonged discussions, the Federal Government did agree to further amend the ASA in 1978 but with the provision that the provinces would not be permitted to "top load" the federal program. This restriction against "top loading" was rejected by British Columbia and Quebec (which had their own provincial programs) and by some producer groups.

Even while the discussions were proceeding with the Federal Government to further amend the agricultural Stabilization Act, several of the provinces had preceded to develop their own short run, ad hoc programs of rice and income support for their cattle and hog producers. It is obvious that this proliferation of provincial programs and the difficulties encountered in getting agreements for amendments in the federal legislation made it very difficult to obtain any workable national consensus on a price and income policy for the red meat sector.

In an attempt to obtain some form of consensus on a policy for the red meat sector. a technical committee of federal and provincial agricultural officials was set up in 1980 and charged with the task of developing a national hog stabilization program. A plan was developed but it, too, met with criticism from many sides. The federal government insisted that any such plan must eliminate the need for provincial programs. Quebec and BC continued to insist on the right to "top load" any federal program. Saskatchewan insisted that price supports be based on a cost-of-production formula, while other groups resisted any price supports based on a cost-of-production guarantee because they believed it would lead eventually to the collapse of the program.

Attempts to launch a national beef stabilization program were even more difficult and contentious. Then federal Minister of Agriculture, Mr. Whelan, argued for some form of supply management program for the beef producers. Mr. Whelan's proposal met with vigorous opposition from several beef groups and the Province of Alberta who were reluctant to have any form of extensive involvement by government in the beef sector.

In July 1982, Ontario agricultural minister, Mr. Timbrell, proposed a "tripartite red meat" policy, in the attempt to reach a compromise among the divergent interest groups involved in the red meat sector. Under Timbrel's proposal, the federal and provincial governments together with the beef and hog producers would contribute equally to the funds required for the operation of the program. The program would provide some minimum form of price support for the cattle and hog producers involved.

At the beginning, the federal government was reluctant to participate in any discussions on the Timbrell proposal. As a result, in March, 1983, the provincial ministers of agriculture set up their own task force to develop a national plan based on the Timbrell proposal. However, the provincial task force was unable to develop a consensus. BC and Quebec insisted on the right to "top load" the program. In the final analysis, only the federal government and the provinces of Alberta, Saskatchewan, Ontario, and somewhat reluctantly, Manitoba, agreed to proceed with the development of the tripartite plan.

Legislation, based on the tripartite proposal, was finally prepared by the federal government and was to be introduced for debate in the House of Commons only to have the federal election called for September, 1984.

In January, 1985, the nearly elected federal Conservative government introduced an amendment to the Agricultural Stabilization Act (Bill C-25) which provided the basis for the development of the "Tripartite Stabilization Plan". The enabling legislation permitted the federal government, the provinces and the red meat producers to develop a mutually acceptible stabilization plan for the red meat industry. The plan was to be voluntary, was to be funded one-third each by the federal government, participating provincial government and the producers, and it continued a prohibition against "top loading" by the provinces.

In a subsequent amendment of the proposed legislation by the federal government (because of pressure from BC and Québec), the provinces would be permitted to return their own stabilization plans (i.e. opened the door once again to provincial top-loading on the tripartite payments), provided, in the federal minister's opinion, the provincial programs did not cause overproduction or provide an unfair financial advantage to a province's producers.

This amendment was severely criticized by the Ontario, Alberta and Saskatchewan hog marketing boards.

On July 4, 1985, the amended legislation (Bill C-25) was passed in the House of Commons in spite of continuing opposition from the Maritimes, Quebec and BC on one side of the fence, and from the three prairie provinces, Ontario and the Cattlemen's Association on the other side of the argument.

It must be kept in mind that Bill C-25 was essentially "enabling legislation" and that the difficult negotiations with the provinces and the commodity groups were still to come. It should also be recognized that these negotiations were further complicated by the US countervailing duties imposed on Canadian live hog exports to the USA.

In the first week of October, 1985, the federal government sent out a draft national tripartite plan for consideration by the provinces and the pertinent commodity groups. The plan proposed that, within five years, the provinces joining the national plan would phase out their existing provincial stabilization programs. During the phase-in period, the total payments to producers could not exceed total previous provincial payments. Few participating provinces would also have to agree to a study of all agricultural support programs that affect production i.e. the study would indicate the provincial and federal "side loading" and "bottom loading" programs that would have to be changed in the future to make certain that producers in some provinces did not have an unfair advantage.

It should also be noted that the proposed federal plan would confine stabilization payments to only that portion of the product consumed in Canada.

The October 1985 federal proposal was an obvious attempt to reach a compromise between the two conflicting groups: the three prairie provinces, Ontario and the Canadian Cattlemen's Association who insist that a national plan should make no provision for provincial "top loading"; Quebec, BC and the Maritime Provinces who have insisted that any national plan must permit provincial "top-loading" to reflect regional cost variations and the right of provincial governments to assist their own farm sectors when they decide that sub assistance is necessary and appropriate.

From both a domestic policy and international trade point of view, there can be little doubt about the need for a nationally coherent stabilization policy for the red meat industry in Canada.

After a decade of debate, it is time for a final resolution of this contentious problem in Canada.

Economic and Constitutional Implications
Inter-Provincial Barriers to Trade

Questions have emerged during the past 10 or 15 years as a result of several federal and provincial policies which have been adopted in Canadian agriculture: Are Canada's internal domestic agricultural policies and programs to be based on provincial self-sufficiency or one common market in Canada? Are Canada's domestic agricultural policies compatible with, or in basic conflict with the provisions of the GATT?

The evidence suggests for some commodities and some sectors that Canada has gradually shifted towards a position of national and provincial sufficiency in terms of its production and marketing policies for agriculture.

Provincial self-sufficiency has had a long history in the fluid milk industry—fluid milk markets have been generally confined to provincial areas and have been administered by marketing agencies under the jurisdiction of the provincial governments. The basis for the provincialization of the industrial milk market started with the establishment of the comprehensive supply management and market sharing quota system adopted by the Canadian Dairy Commission in 1971 and formalized in 1975 with the establishment of the Canadian Milk Supply Management Committee.

The passing of the farm Products Marketing Agencies Act by the federal government in 1971 set the stage for national and provincial self-sufficiency policies for the eggs, chicken and turkey commodities in the 1970's.

The amendment of the Agricultural Stabilization act in 1975 which provided that the provinces could "top load" the ASA program, opened the door to the proliferation of provincial programs for several commodities, mainly beef and pork producers.

The results of all these programs may be summarized as follows:

1. Establishment of national and provincial quotas for several of the major commodities.

2. The development of a variety of "top loading" and "bottom loading" payments, subsidies and inducements which have effectively divided the country into ten market economies.

3. Many of these federal and provincial policies and programs have effectively created a network of countervailing subsidies which are non-productive and which effectively lead to a competition among the provincial treasuries of the country.

4. Several of these domestic policies hav led to serious inconsistencies and overt conflicts with other trading partners and with the general provisions of the GATT.

An examination of several decisions by the Privy Council of Great Britain and the Supreme Court of Canada on a variety of agricultural policies and programs indicates that the spirit of the Constitutional Act (1982), if not the legal provisions, provides for one Common Market in Canada.

I believe that the constitution provides for the "One Common Market" in Canada in article 121 which states:

> All articles of the growth, produce or manufacture of any one of the Provinces shall, from and after the Union, be free into each of the other Provinces.

In a statement relating to the Supreme Court decision in 1971 regarding the famous "chicken and egg war" in Canada, Mr. Justice Bora Laskin observed:

> ...to permit each Province to seek its own advantage, so to speak, through a figurative sealing of its borders to entry of goods from others would be to deny one of the objects of Confederation, evidenced by the catalogue of federal prowers and by S. 121, namely, to form an economic unit of the whole of Canada.
>
> . . . .
>
> ...The existence of egg marketing schemes in more than one Province, makes it clear that interprovincial trade in eggs is being struck at by the provincial barriers to their movement into various provincial markets.

On the basis of the 16 cases which I examined which related to agricultural legislation brought before the Privy Council of Great Britain or the Supreme Court of Canada between 1931 and 1978, I have concluded that the Fathers of Confederation did indeed have in mind that Canada should be one common market.

The implications of the shift towards provincial self-sufficiency in agricultural policies and programs have not been confined to Canada. Several of these programs have led to difficulties in the international arena.

It is true that Canada was successful in obtaining agreement from Contracting parties to GATT for an exemption for its chicken, eggs, and turkey supply management programs under article XI of the GATT which establishes a general ban on restrictive measures "other than duties, taxes or other charges" on imports and exports. But it was truly that—an exemption to the general spirit and intent of the provisions of the GATT.

The Canadian-US Hog War

On May 15, 1984, US Senator Robert Dole, chairman of the Senate Committee on Finance, sent a letter to the chairman of the US International Frank Commission requesting the ITC to "conduct an investigation under section 332 of the Tariff Act of 1930 on the competitive portion of Canadian live swine and pork in the United states market".

This letter fired the first official shot in an agricultural trade conflict that was to involve politicians, bureucrats and hog producers on both sides of the border.

The central issue in the conflict involved a charge by American pork producers that subsidized Canadian hog/pork exports to the USA caused serious, unfair and continuing injury to the American hog/pork industry. The remedy requested was a countervailing duty on Canadian hog/pork exports to the USA, equivalent to the domestic subsidies paid on those products.

Canada and the USA have operated for many years within a relatively free trading framework for hogs and pork. Indeed, since 1980 (under the negotiated results of the Tokyo Round of GATT) Canada and the USA have adopted a zero bound duty for hogs as well as for fresh or frozen pork products. The restraints on trade which do exit for these products are generally related to non-tariff barriers such as health and sanitary regulations.

Between 1974 and 1978, the amount of pork imported into Canada from the USA exceeded by a wide margin the amount of Canadian pork exports to the USA. In 1977, for example, total pork imports from the US to Canada amounted to 198 million pounds, compared with the reverse flow to the US of only 20 million pounds. Between 1979 and 1984, by contrast, the amount of Canadian pork exports to the USA exceeded the US exports to Canada (table 1). It should be noted that in 1983 Canadian exports of pork to the USA represented only 1.8 per cent of total US pork consumption. By contrast, in 1977, US pork exports to Canada represented nearly 17 per cent of Canadian pork consumption or approximately 14.5 per cent of Canadian pork production.

In a preliminary analysis of the situation (March 26, 1985), the US Commerce Department calculated the net subsidies paid in Canada to be as follows:

1. Benefits received under the federal Agricultural Stabilization Act = 2.6 cents/lb.
2. Benefits received under the provincial hog stabilization programs = 2.5 cents/lb.
3. Record of performance program = 0.1 cents/lb.
4. Hog carcass settlement system = 0.1 cents/lb.
5. Nfd. low interest loans to hog producers = 0.002 cents/lb.
6. Quebec grants to hog producers = 0.005 cents/lb.

The preliminary countervailing duties (equivilent to the Canadian net subsidies) on Canadian hog/pork exports to the USA counted to 5.3 cents per pound for dressed pork and 3.8 cents per pound for live hogs.

After further analysis, the US Department of Commerce increased the countervailing duties in its final determination (June 10, 1985) to 5.523 cents per pound dressed weight and 4.39 cents per pound live weight.

In a final decision on the matter on July 25, 1985, the International Trade Commission confirmed the countervailing duties on canadian live hog exports to the USA but it eliminated the countervailing duties on pork exports to the USA.

The duties are to remain in effect for an indefinite period.

At the present time, the ITC decision is being challenged on both sides of the border: the US producers want the CVD extended to Canadian pork product exports to the USA; the Canadian producers want the CVD on live hog exports to the USA eliminated.

There can be, no doubt, that the US decision has had damaging consequances for the Canadian hog/pork industry. What the eventual outcome of the situation will be is difficult to predict at this time. Some hog producers in Canada contend that the only option left open is to adopt some form of "supply management" program in Canada. Other producers argue that the only sensible option would be the one which would put Canada's "own subsidy house" in order and to continue to press the USA to reverse its position on the countervailing duty decision.

The fact that Canada has exported such a substantial proportion of its hog/pork production to the USA during recent years suggests that much is at stake in the final outcome of the Canadian - US hog war.

Troubles with the European Community Over Beef and Pork

A sudden and unexpected surge of beef and pork products into Canada from the EC in 1983 marked the beginning of prolonged and controversial debates between Canada and the EC over agricultural trade relationships. The Canadian livestock producers and the most processing industry charged that the EC was dumping highly subsidized beef and pork products in Canada and that serious injury was being inflicted on the Canadian red meat industry by these subsidized products. The Canadian Pork Council and the Canadian Cattlemen's Association have pressed the Federal Government to undertake remedial actions against this type of unfair competition. The requested actions included: a surtax on the EC pork and beef experts equivalent to the amount of the subsidy on those products; import quotas under Canada's Meat Import Law; and appropriate action under Canada's countervailing duty legislation.

Between 1981 and 1984 there was a very significant increase in EC exports of red meat and red meat products to Canada. Frozen, boneless beef exports from Ireland increased from 584 tonnes in 1981 to 17,438 tonnes in 1984; the corresponding exports from Denmark increased from 624 tonnes to 5190 tonnes (table 4). Danish exports of various pork products (pork bellies, hams not cured or cooled, and pork shoulders and picnic butts, and pork, fresh and frozen) to Canada between 1981 and 1984 increased from virtually nothing to substantial amounts (table 4).

The most spectacular increases occurred in canned ham. EC exports of this product to Canada increased from 19,647 kg. in 1981 to 709,125 kg. in 1984, an increase of over 36 times.

There is little doubt that export subsidies were and are an integral and important part of the increased EC exports of red meat products to Canada.

The Beef and Veal Issue in the EC

The first steps taken to organize a Common market policy for beef and veal occurred in 1968 when a price support system was established for these products. The principal support mechanism involves internal support measures such as intervention purchases (and storage) at stipulated support prices, private storage subsidies, measures affecting imports from outside the EC (variable levies), and export subsidies on EC exports to third countries.

The support price for beef and veal is calculated in the following way:

1. A guide price is calculated - price which producers should obtain under "normal" market conditions.

2. Intervestian price: normally set at 90 per cent of guide price and is the price used in determining the buying-in price for EC price support programs.

A variable levy, which is used to protect EC producers against imports of beef and veal from third countries, is calculated roughly as shown in the following example:

1. EC guide price (live weight) = 205.02 ECU/kg.
2. Less import price plus duty = 103.25 ECU/kg.
3. Basic variable import levy = 101.77 ECU/kg.

Export refunds subsidies have not generally been set on the basis of a mechanical formula but invariablly take account of the following factors:

1. current and future world market situations;
2. state of the EC market situation
3. competitive situations in third country markets
4. possible political reaction in third countries e.g. the possibility of countervailing duties or quotas being imposed by the importing country against the subsidized imports.

The consequences of the common market policy for beef and veal have been extremely significant:

1. Beef surpluses (international purchases) in storage increased from nearly zero in 1981 to an expected one million tonnes by the end of 1985. Over 350,000 tonnes of that surplus beef has been in storage for over a year.

2. Between 1981 and 1985, the annual cost to the EC of the beef and veal support program has increased from 1.4 billion to 2.2 billion ECU's (table 11). Almost half of that total support expenditure has been spent on export subsidies; these subsidies have ranged as high as 65 cents per pound of beef.

It is estimated that in 1981, EC manufacturing beef represented 2.9 per cent of total imports or one per cent of the Canadian market. By 1984 these figures had increased to 40 per cent of all manufactured beef imports or 17 per cent of the Canadian market. it is projected that EC beef imports could expand to almost one-third of the Canadian market by the end of 1986.

In the attempt to cope with this surge of beef exports to Canada from the EC, Canada invoked the provisions of the Meat Import Act (1982) in December, 1984. In 1984 the EC shipped 45 million pounds of beef to Canada, far greater than anything shipped in the past. This beef was shipped into Canada on the basis of export subsidies ranging from 39 to 48 cents per pound. Under the quota allocations set under the Meat Import Law in December, 1989, the EC was given an allocation of only 6 million pounds for the 12 month period following October, 1984.

While this allocation made the Canadian Cattlemen's Association happy, it angered the EC. The EC filed a tariff request with the GATT which had the objective of retaliating against Canadian exports to the EC of maple syrup, mustard seed, rye whisky, animal feed and tabacco.

In June, 1985, the federal government increased the quota allocation under the Meat Import Law from the original 6 million pounds to 23.5 million pounds for the EC. This change brought a change from the Canadian Cattlemen's Association that they had been betrayed by their federal government.

This criticism was offset somewhat by the federal government's public support of the Cattlemen's request to have a countervail action launched against the subsidized beef imports from the EC.

The CCA has now launched a formal request with Revenue Canada to place countervailing duties on the EC beef imports. If Revenue Canada agrees (October 18, 1985) a more detailed 90-day investigation will be undertaken by the Canadian Import Tribunal, at the end of which time a provincial countervailing tariff is established if the finding is favorable to the CCA This analysis would then be followed by a final 120-day investigation at which time a final determination is made on the countervailing duty.

What the eventual outcome of the Canadian - EC beef conflict will be can only be a matter of speculation at the present time. But the problem in the EC is serious. In the first week of October, 1985, it was reported that the EC was searching for additional storage space for surplus beef stocks in Austria, Switzerland and neighboring countries. Ships with cold storage facilities were also being used to store the surplus beef. Beef, presently pouring into EC intervention stocks at the rate of 25,000 tonnes per week, will generate a beef surplus of over one million tonnes by the end of 1985.

The Pork Situation In the EC

The price support system for pigment in the EC suffers somewhat from that set for beef and veal.

In general, the price support system for EC pigment includes a number of elements: intervention purchase and aids to private storage; a system of "sluicegate prices and import levies on imports from third countries; a system of export refunds for product exported outside the EC.

The calculation of the price support level for pigment is based on two elements: the basic price and a reference price. The basic price for pigment is set once a year with other farm prices and is normally set at a level which contributes towards a "stable market" situation without lending to the production of surpluses. The "reference price" is the internal market price based on prices reported from representative markets within the EC.

Intervention measures are undertaken to support prices for pigment whenever the reference price falls below 103 per cent of the basic price. While there is provision for public intervention purchases of pigment, this type of support has normally been avoided. Instead other support measures are used such as public subsidies for private storage.

Protection against pigment imports to the EC from third countries is based on basic import levies and sluicegate prices.

The basic import levy is fixed at a level which ensures that EC pig producers are not adversely affected when world cereal feed costs are significantly below EC costs.

The sluicegate price prevents third country suppliers from "dumping" pigment into the EC at a price significantly below world production costs.

An example will illustrate how the import levy is calculated:

1. Effective minimum import price for a pig carcass = 189.12 ECU per kg.
2. EC cost of production of pig carcass = 180.16 ECU per kg.
3. Import levy (7% of sluicegate price) = 8.96 ECU per kg.
4. Calculated world cost of production of pig carcass (also referred to as sluicegate price) = 141.29 ECU per kg.
5. Import levy: difference between minimum import price and world cost of production = 38.87 ECU per kg.

Note that the system of sluicegate prices and import levies provide an effective minimum import price below which pigment cannot enter the EC from outside. The minimum import price should always be higher than the EC cost of purchasing pigment (note minimum import price = EC cost of production plus import level of 7 per cent of sluicegate price.)

Export refunds (subsidies) for EC pigment exports are not based on a mechanical formula. The refunds are based, instead on five factors:

1. prices and supplies of pigment in the EC
2. the prices and supplies of pigment in world markets
3. the difference in feed grain costs on world and EC markets
4. the competitive conditions in third country markets
5. political factors e.g. possibility of retaliation by competing or importing countries.

The amount spent by the EC for the support of the pigment industry increased from an annual expenditure of 155 million ECU in 1981 to 195 million ECU in 1985 (table 11).

Between 1980 and 1983, Canadian imports of canned ham from EC increased from 89,000 to 2,157,000 pounds. During the same period of time canned pork-based luncheon meat increased from 484,000 to 4,650,000 pounds.

As a result of this surge in EC subsidized exports of pork products to Canada, the Canadian Pork Council petitioned Revenue Canada for countervailing duties on the EC pork exports to Canada. In April, 1984, Revenue Canada levied provisional import duties on canned ham and picnic shoulder meats imported from Denmark and the Netherlands. The duties assessed ranged from 27 cents to 46 cents per pound, equivalent to the EC subsidies on the products.

On August 7, 1984, the Canadian Import Tribunal concluded after further investigation that:

1. The importation of subsidized canned ham under 1.5 kg per can, originating in or exported from Denmark and the Netherlands has caused, is causing and is liable to cause material injury to the production of like pork products in Canada;

2. Similar findings were uncovered by the Import Tribunal for canned pork-based luncheon meat containing, by weight, more than 20 per cent pork;

3. The Canadian Import Tribunal did not find injury resulting from the import of canned picnic from Denmark and the Netherlands.

In March, 1985, the Canadian Pork Council charged that Denmark dumped 3.5 million pounds of subsidized fresh pork into the Canadian market during the first seven weeks of the year. The Pork Council claimed that the EC subsidy amounted to 32 cents per pound. To date, the Pork Council has not requested Revenue Canada to impose countervailing duties on the EC exports of fresh pork.

Prospects for the Red Meat Industry in Canada

In preparation for any further discussion about a policy for the red meat sector in Canada, what conclusions may be drawn from the past debates?

1. It is clear that the majority of the hog and cattle producers are strongly opposed to any form of supply management program in their industry?

2. It is also clear that the ad hoc, short-run provincial programs for the red meat sector are not a satisfactory form of policy for the livestock industry in the long run. These programs are stop-gap, at best, and, at worst, will lead to costly and unproductive forms of competition among the treasuries of the provinces.

3. At the same time, it is clear that unless a satisfactory federal (national) policy is developed for the red meat sector, the provinces will continue to guard their right to develop their own programs and to "top load" existing federal programs.

4. It has become evident that whatever policies are developed in Canada for the red meat industry, the international implications of such policies cannot be ignored. The recent discussions between officials of Canada and the United States about the Canadian hog price and income support programs is an indication that national policies cannot be isolated from their international consequences.

5. It does appear from the past debates that cattle and hog producers do want and need some form of price and income support for their industry. The questions to be resolved appear to these: What type of price and income support programs would be best for the industry: At what level should these supports be set? How can the federal and provincial policy interests be reconciled? Who should pay the costs of these programs.

6. Finally, in developing a price and income stabilization policy for the red meat sector in Canada, the reality of limited government budgets must be kept in mind. At the present time, the

federal government has a budgetary deficit of close to $35 billion and a net national debt of over $150 billion. The provincial governments, too, have incurred budgetary deficits and their debts have begun to reach serious limits.

It is within the context of severely constrained public resources that farm policies must compete with other urgent social and economic programs for a position in the list of priorities which governments decide to support.

Keeping in mind the lessons and conclusions which can be drawn from the lengthy debates relating to the red meat industry over the past 15 years, and recognizing the basic policy premises outlined in an earlier part of this presentation, what possibilities are there that the proposed tripartite red meat stabilization program could be used as the basis for a revitalized policy for the industry?

Apart from the fact that the tripartite proposal does represent the end product of extensive discussions among major participants in the red meat sector, and to that extent does indicate considerable political acceptability, it does include some important economic considerations.

1. The proposal provides a mechanism to bring the federal and provincial jurisdictions together under one national policy.

2. The equal sharing of costs of the proposal among the federal and provincial governments and the producers does have considerable merit given the limited public resources available for such a program.

3. The proposal does attempt to anticipate the international consequences of the domestic policy by limiting support payments to the domestically consumed portion of the red meat produced in Canada. At the same time, the proposal recognizes that the red meat sector must be based on an open economy, not an economy of national self-sufficiency.

It should be noted here that a quite successful precedent has been established for the proposed tripartite red meat policy in the national crop insurance program which has been operating since 1960. The crop insurance program, too, is a form of tripartite policy—both levels of government and the participating producers share in the costs and benefits of the program.

While the proposed tripartite red meat stabilization program has much to commend it, there are some major obstacles still to be overcome. The most important obstacle concerns the insistence by Quebec and British Columbia that the provinces have the right to "top load" any national program. Another long-run risk relates to the level of the price support provided for under the program. If, over time, the producers insist on higher and higher levels of price and income support (and correspondingly less emphasis on the stabilization feature of the present proposal), the whole objective of the program will have been changed and the resulting fiscal consequences may lead governments to withdraw from the program.

A price stabilization policy for the red meat industry will not be the universal pinaces for its ills. It is a matter of helping, what is basically a viable industry, to cope with periodic and crippling instability in the industry. From that point of view, the use of public funds can be seen as an "investment" in an industry that contributes in a very significant way to the creation of income and employment in the general economy, and which, if given the proper incentives, can take on much greater importance in the international markets of the world.

Table 1

Imports to Canada of Red Meat and Red Meat Products By Commodity and Country

	1981	1982	1983	1984
	tonne	tonne	tonne	tonne
1. Beef, Fresh or chilled, boneless				
Denmark	-	-	-	35
2. Beef, frozen boneless				
Ireland	584	1,935	6,593	17,438
Denmark	624	1,578	-	5,190
West Germany	-	-	-	21
3. Beef, fresh or frozen NES				
Ireland	18	-	126	66
Denmark	-	-	-	19
4. Pork bellies, fresh or frozen				
Denmark	-	-	-	582
5. Hams, not cured or cooked				
Denmark	-	-	-	160
6. Pork shoulders, picnics butt fresh, frozen				
Denmark	164	-	-	929
7. Pork spare ribs, fresh or frozen				
Belgium - Luxemburg	16	-	-	-
Denmark	593	82	-	420
8. Pork, fresh or frozen				
Denmark	220	127	-	1,574
9. Meat, fresh or frozen, NES				
UK	2	15	-	-
Belgium - Luxemburg	2	19	23	65
France	12	1	4	2
Netherlands	182	43	89	102

		kg.	kg.	kg.	kg.
10.	Extracts of meat, not canned				
	EK	103,102	77,986	14,175	18,634
	Denmark	80,639	71,985	54,001	18,000
	France	-	-	-	-
	Italy	-	-	12,669	26,674
11.	Corned beef, canned				
	UK	362	103	251	93,293
	Belgium-Luxemburg	-	-	816	-
	Denmark	-	-	-	15,096
12.	Beef and veal, canned NES				
	UK	1,870	15,306	3,643	11,455
	Ireland	-	34,794	23,930	26,893
	Italy	158,587	99,655	219,012	161,946
13.	Hams, canned				
	UK	544	-	-	-
	Belgium - Luxemburg	-	-	18,333	59,160
	Netherlands	16,819	23,329	897,384	538,660
14.	Luncheon meat, canned				
	Belgium - Luxemburg	-	-	-	14,710
	Denmark	198,647	369,949	400,779	481,232
15.	Meat and Meat Preparations, canned NES				
	UK	1,804	34	9,228	190
	Belgium - Luxemburg	-	-	19,192	9,792
	Denmark	280,349	301,568	191,933	102,694
	France	145,665	387,998	875,353	457,348
	Italy	7,937	23,882	59,864	103,501
	Netherlands	-	12,757	-	-
	Ireland	-	12,757	-	-
	West Germany	-	2,927	183	-

Table 2

Pork: U.S. production, imports for consumption, exports of domestic merchandise, and apparent consumption, 1979-83, and January-June 1983, and January-August 1984

Period	Production	Imports	Exports	Apparent Consumption[1]	Imports as a Share of Consumption	U.S. Imports from Canada		Exports as a Share of Production	U.S. Exports to Canada	
						Quantity	Percent of Total U.S. consumption		Quantity	Percent of Total Canadian Consumption
	. . . .	Million pounds	. . . .		Percent	Million pounds		Percent	Million pounds	
1979	15,450	499	291	15,353	3.3	108	0.7	1.9	68	4.4
1980	16,616	550	252	16,574	3.3	203	1.2	1.5	42	2.4
1981	15,872	541	307	15,927	3.4	201	1.3	1.9	39	2.3
1982	14,229	612	214	14,425	4.2	280	1.9	1.5	25	1.7
1983	15,199	702	219	15,369	4.6	275	1.8	1.4	27	1.7
Jan.-Aug.										
1983[3]	9,717	466	144	10,039	4.6	187	1.9	1.5	17	1.6
1984	9,671	625	122	10,174	6.1	240	2.4	1.3	14	1.4

[1] Does not include changes in inventory.

[2] Not available. (sic)

[3] Estimated by staff of USITC.

Source: Production and apparent consumption, compiled from official statistics of the U.S. Department of Agriculture, imports and Exports, compiled from official statistics of the U.S. Department of Commerce.

Note: This table was taken from U.S. International Trade Commission, USITC Publication 1615, Washington, D.C., November, 1984, p. 146.

Table 3

Pork: Canadian production, imports, exports, apparent consumption, ratio of exports to production, and ratio of imports to consumption, 1979-83

Year	Production	Imports	Exports	Apparent Consumption[1]	Exports as a Share of Production	Exports to U.S.		Imports as a Share Apparent Consumption	Imports from the U.S.	
						Quantity	Share of Production		Quantity	Share of Consumption
	. . . . Million pounds				Percent	Million pounds	Percent	Percent	Million pounds	Percent
1979	1,653	74	175	1,552	10.6	108	6.5	4.8	68	4.4
1980	1,933	43	260	1,716	13.5	203	10.5	2.5	42	2.4
1981	1,916	44	248	1,718	12.9	201	10.5	2.6	39	2.3
1982	1,836	31	359	1,514	19.6	280	15.2	2.0	25	1.7
1983	1,878	42	346	1,572	18.4	275	14.6	2.7	27	1.7

[1] Does not include changes in inventories.

Source: Production, imports, exports, and apparent consumption, compiled from official statistics of the U.S. Department of Agriculture; exports to the United States and imports from the United States, compiled from official statistics of the U.S. Department of Commerce.

Note: This table was taken from U.S. International Trade Commission, USITC Publication 1615, Washington, D.C., November, 1984, p.167.

Table 4

Pork and Live Swine: Canadian exports, by product types, 1979-83 and January-April 1984

Product type	1979	1980	1981	1982	1983	January-April 1984
	. . . . . . (In thousands of Canadian dollars)					
Fresh or Frozen pork[1]	244,593	303,766	383,563	522,177	456,683	157,460
Live Swine[2]	18,588	28,887	21,975	52,415	69,682	55,788
Prepared or preserved pork[3]	13,382	12,060	14,927	18,500	19,054	6,131
Canned hams[4]	467	1,917	3,993	4,505	2,233	85
TOTAL	277,030	346,630	424,458	597,597	547,652	219,464

[1] Canadian commodities Nos. 13-23, 13-24, 13-29, 15-09, 15-18, and 15-24.

[2] Canadian commodities Nos. 3-49.

[3] Canadian commodities Nos. 13-24, 13-29, 15-09, 15-18, and 15-24.

[4] Canadian commodities Nos. 17-24 and 17-29.

Source: Compiled from official statistics of Statistics Canada.

Note: This table was taken from the U.S. International Trade Commission, USITC Publication 1615, Washington, D. C., November, 1984, p. 169.

AGRICULTURE IN THE EUROPEAN COMMUNITY

Table 5

Member States	Utilised agricultural area (1000 km^2)	Persons employed in the agricultural sector (x 1000)	Final production in agriculture	
			Mrd ECU	%
B	14,33	107	4,44	3,1
D	121,37	1,381	26,72	18,4
DK	28,88	207	5,75	4,0
F	317,28	1,738	37,35	25,8
GR	92,34	1,008	7,43	5,1
I	178,36	2,545	28,46	19,6
IRL	57,11	196	3,15	2,2
L	1,27	8	0,16	0,1
NL	20,13	248	12,07	8,3
UK	188,14	636	19,44	13,4
EEC	1020,31	8,074	144,97	100,0

Source: E.C. European Agricultural Guidance and Guarantee Fund, 1984.

Table 6 **Final production in agriculture (1982)**

Product	Quantity (x 1000)	Value (Mrd ECU)
Wheat	59,616 t	10,6
Other cereals (oye, oats, barley, maize, rice)	71,924 t	8,6
White sugar	13,942 t	3,5
Tobacco	329 t	1,0
Olive oil	630 t	1,7
Oilseeds	3,575 t	1,4
Fresh fruit	22,665 t	5,7
Fresh vegetables	28,670 t	9,7
Milk	108,135 t	27,8
Eggs and poultry meat	8,685 t	10,7
Beef and veal	6,652 t	21,1
Pigmeat	10,224 t	17,2
Sheepmeat and goatmeat	704 t	2,6
Wine	140,574 hl	8,4
Other	37,051 t	14,8
Total		144,8

Source: E.C. - EAGGF 1984 Edition.

EUROPEAN COMMUNITY REVENUE (1)

Million ECU

Table 7

Type of revenue	1981	1982	1983	1984 (2)	1985 (3)
Customs duties	6,392	6,815	6,989	7,623	8,096
Agricultural levies	1,265	1,522	1,347	1,947	1,388
Sugar levies	483	706	948	1,003	987
VAT	9,884	12,197	13,699	14,566	15,222
Other	392	360	1,783	222	527
Total +	18,434	21,427	24,766	25,361	26,220
additional finance (4)	-	-	-	2,333	1,883
TOTAL	18,434	21,427	24,766	27,694	28,103
Breakdown by country :					
from Belgium	991	1,148	1,216	1,339	1,390
Denmark	354	402	480	508	582
Germany	5,057	5,698	6,472	6,926	7,797
Greece	254	382	378	477	470
France	3,491	4,226	4,506	5,039	5,477
Ireland	159	208	270	251	298
Italy	2,526	2,487	2,999	3,561	3,777
Luxembourg	27	30	44	40	50
Netherlands	1,287	1,466	1,565	1,669	1,782
United Kingdom	3,877	5,116	5,084	5,330	6,224
VAT rate %	0.79	0.92	1.0	1.0	1.12

1) EEC expenditure is financed exclusively from own resources, i.e. not by contributions or grants from Member States.

2) Budget appropriations in 1984.

3) Preliminary budget 1985.

4) This additional finance takes into account the expected evolution of expenditure in 1984 and 1985.

Source: EC - EAGGF 1984 Edition.

Table 8

EUROPEAN COMMUNITY EXPENDITURE

Sector	1981		1982		1983		1984		1985	
	Mio ECU	%	Mio ECU	%	Mio ECU	%	Mio ECU	%	Mio ECU	%
EAGGF - Guarantee Section of which:	10,980	61,7	12,406	60,0	15,812	64,8	18,631	67,3	19,315	68,7
Crop products	5,221	29,3	6,691	32,8	8,516	34,9	9,082	32,8	8,814	31,5
Livestock products	5,238	29,4	4,988	24,4	6,807	27,9	8,833	31,9	8,447	30,1
Agri-monetary measures	238	1,3	313	1,5	481	2,0	410	1,5	126	0,4
EAGGF - Guidance Section	580	3,3	654	3,2	654	2,7	675	2,4	940	3,3
Fisheries			(55)	0,3	(57)	0,2	112	0,4	140	0,5
Social policy			1,061	5,2	1,022	4,2				
of which Social Fund	746	4,2	906	4,4	891	3,7	1,644	5,9	1,601	5,7
Regional development			3,008	14,7	2,409	9,9				
of which Regional Fund	799	4,5	973	4,8	1,256	5,2	1,455	5,3	1,741	6,2
Research, Investment, Energy	359	2,0	438	2,1	1,315	5,4	1,740	6,3	776	2,8
Development aid, of which	859	4,8	786	3,9	1,002	4,1	897	3,2	1,152	4,1
Food aid	602	3,4	540	2,6	541	2,2				
Financial aid	257	1,4	246	1,3	461	1,9				
Other	128	0,7	-		-		173	0,6	-	
Administration	944	5,3	1,010	5,0	1,120	4,6	1,264	4,6	1,358	4,8
Reimbursements to Member States	2,394	13,5	1,049	5,1	1,050	4,3	1,103	4,0	1,079	3,8
Total	17,789	100	20,423	100	24,407	100	27,694	100	28,103	100

Sources : **EAGGF Financial Reports; Annual Reports of the Court of Auditors; budget accounts; 1984 and 1985 budgets with corrections.**

Soruce: EC - EAGGF 1984 Edition.

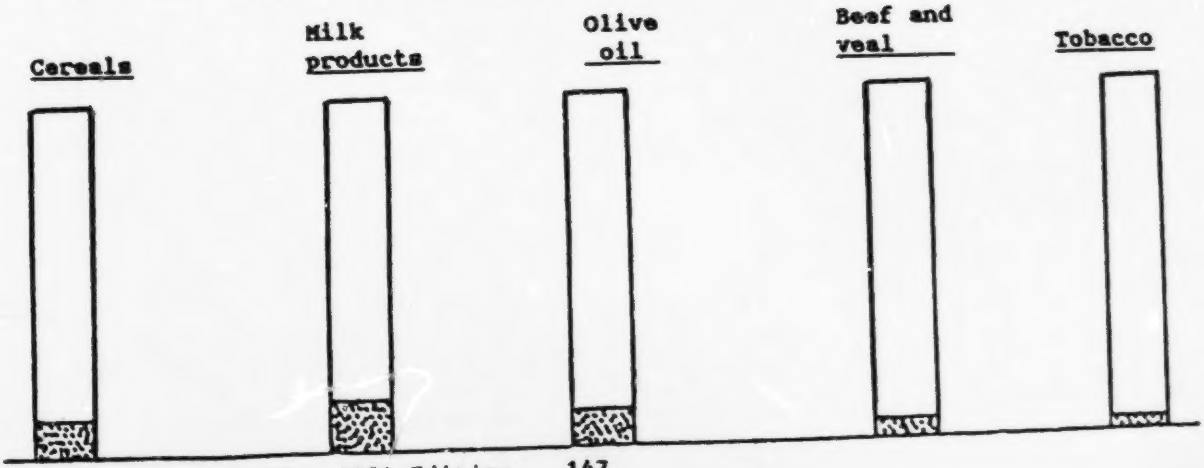
QUANTITIES AND VALUE OF PRODUCTS IN PUBLIC STORAGE

Table 9

Product	Situation at 31.12.1982		Situation at 30.11.1983	
	Tonnes	Million ECU	Tonnes	Million ECU
Cereals	9,667,000	1,840	9,541.553	1,854
Skimmed milk powder	605,000	854	957,201	1,458
Butter	139,000	467	686,278	2,475
Olive oil	181,000	288	120,745	175
Colza	38,600	15	-	-
Beef/veal	217,000	504	390,084	1,042
Tobacco	37,500	43	30,589	31
Total		4,011		7,035
Cf value of total agricultural production (1982)				145,000

Source: EC - EAGGF 1984 Edition.

Table 10 Value of stocks as a percentage of value of production



Source: EC - EAGGF 1984 Edition.

Table 11

EAGGF. GUARANTEE SECTION. EXPENDITURE BY SECTOR

Million ECU

Type of expenditure	1981	1982	1983	1984 (3)	1985 (3)
Cereals and rice	1,934	1,875	2,534	2,114	2,959
Milk products	3,821	3,865	5,451	7,755	8,050
- proportion financed by the coresponsibility levy (1)	478	537	527	972	1,283
Oils and fats	1,025	1,214	1,763	1,838	2,157
of which: olive oil aids	377	407	675	888	935
colza, rape and sunflower seed aids	571	703	946	950	1,222
Sugar	767	1,242	1,316	1,602	1,476
Protein plants				155	160
Beef and veal	1,437	1,159	1,737	2,010	2,215
Sheepmeat and goatmeat	191	252	306	509	417
Pigmeat	155	112	145	207	195
Eggs and poultrymeat	84	104	123	126	136
Fruit and vegetables	641	914	1,196	1,332	1,256
of which : processed products	418	549	746	832	835
Wine	459	571	659	1,038	691
of which : distillation measures	315	390	351	809	453
Tobacco	362	623	671	795	826
Fishery products	28	34	(26)*	(43)*	(31)*
Other products	184	253	216	209	277
Processed products	282	414	343	351	390
Total expenditure	10,903	12,092	15,432	18,097	18,670
Monetary compensatory amounts	238	313	488	409	126
EAGGF GUARANTEE SEC. EXPENDITURE Total	11,141 (2)	12,406	15,920 (2)	18,506 (2)	18,796

* As from 1983, treated as expenditure under the "Fisheries policy" Chapter of the Budget.

(1) Contribution of producers towards the cost of the common organization of the market.

(2) Expenditure before closure of account.

(3) Budget planning, 1984 including additional requirements.

Source: EC - EAGGF 1984 Edition.

EAGGF, GUARANTEE SECTION, EXPENDITURE FOR 1983 BY SECTOR AND ECONOMIC NATURE OF THE MEASURES

Table 12

Million ECU

Sectors	Total expenditure	Export refunds	Breakdown by type of measure				
			Market stabilization measures in the form of				
			Storage	Withdrawal from the market and similar operations	Prices subsidies	Guidance premiums	Total
ereals and rice	2,534	1,593	477	-	464	-	941
ilk products	4,396	1,327	1,029	-	1,948	92	3,069
f which : butter	(1,406)	(499)	(341)	-	(566)	-	(907)
live oil	675	10	12	-	653	-	665
olza, rape and sunflower	925	4	- 4	-	925	-	921
ugar	1,316	758	550	-	8	-	558
eef and veal	1,737	828	632	-	173	103	908
ruit and vegetables	1,196	58	-	304	834	-	1,138
ine	659	20	143	391	105	-	639
obacco	671	28	29	-	615	-	643
heepmeat and goatmeat	306	-	-	-	306	-	306
ther (incl. fishery products)	1,016	595	25	17	379	-	422
otal A	15,431	5,220	2,893	712	6,410	195	10,211
onetary compensatory amounts	489	340	-	-	149	-	149
otal B %	15,920 = 100 %	5,560 = 35 %	2,893 = 18 %	712 = 5 %	6,559 = 41 %	195 = 1 %	10,360 = 65 %

ource: EC - EAGGF 1984 Edition.

Appendix 2

Inquiry No.: GIC-1-84

Table 13

CANNED HAM UNDER 1.5 KILOGRAMS PER CAN

Apparent Imports
(000's lbs.)

Country	1980	%	1981	%	1982	%	1983	%	Jan. 1-March 31 1983	%	Jan. 1-March 31 1984	%
Denmark	-	-	70	49	90	54	171	8	63	11	108	15
Netherlands	29	33	74	51	76	46	1,986	92	510	89	634	85
Other Countries	60	67	-	-	-	-	-	-	-	-	-	-
Total	89	100	144	100	166	100	2,157	100	573	100	742	100
% Increase (decrease) from previous period			62		15		1,199				29	

Source: Replies to questionnaires and Statistics Canada c.c.: 017-24-10

Appendix 3

Inquiry No.: GIC-1-84

Table 14

CANNED PICNIC UNDER 1.5 KILOGRAMS PER CAN

Apparent Imports
(000's lbs.)

Country	1980	%	1981	%	1982	%	1983	%	Jan. 1-March 31 1983	%	Jan. 1-March 31 1984	%
Denmark	125	95	205	84	215	84	142	100	31	100	7	100
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-
Other Countries	6	5	39	16	40	16	-	-	-	-	-	-
Total	131	100	244	100	255	100	142	100	31	100	7	100
% Increase (decrease) from previous period			86		5		(44)				(77)	

Source: Replies to questionnaires and Statistics Canada c.c.: 017-99-45

Table 15

CANNED HAM AND CANNED PICNIC UNDER 1.5 KILOGRAMS PER CAN

Apparent Market
(000's lbs.)

	1980	%	1981	%	1982	%	1983	%	Jan. 1-March 31 1983	%	Jan. 1-March 31 1984	%
Total Producers	8,534	98	8,480	96	6,438	94	5,682	72	1,077	66	1,031	66
Sales from Imports												
Denmark	76	1	232	3	282	4	329	4	80	5	117	8
Netherlands	29	-	74	1	54	1	1,934	24	469	29	406	26
Other Countries	66	1	39	-	40	1	-	-	-	-	-	-
Total Imports	171	2	345	4	386	6	2,263	28	549	34	523	34
Total Market	8,705	100	8,825	100	6,814	100	7,945	100	1,626	100	1,554	100
% Increase (decrease) from previous period			1		(23)		17				(4)	

Source: Replies to questionnaires and Statistics Canada 017-24-10

Note: In order to preserve confidentiality, canned ham and canned picnic figures have been aggregated.

Revision from correction received June 8, 1984.

Table 16

CANNED PICNIC UNDER 1.5 KILOGRAMS PER CAN

- Average Price Per Case of 12 cans -

- 1 lb. Can Size -

	1982				1983				1984
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1st Qtr.
stic	36.33	34.20	34.69	35.64	37.88	37.68	37.74	37.26	35.55
ark	33.24	33.31	33.01	33.86	28.61	31.47	24.10	24.05	24.16
e of Subsidy nmark	3.48	3.60	3.44	3.32	3.40	3.48	3.24	3.16	3.16

rce: Replies to Supplementary Questionnaires received from 25 retailers situated across Canada. Volumes purchased by these retailers represented 42% of the market in 1982, 37% of the market in 1983 and 29% of the market in 1984.

POOR
QUALITY
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